■ CHERNOBYL: WHAT REALLY HAPPENED ■ WHO SHOULD SEE YOUR GENETIC TESTS? ■

■ MIT REACTS TO COLD FUSION ■ THE GAIA HYPOTHESIS: IS THE EARTH ALIVE? ■

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY JULY 1989 $3.00

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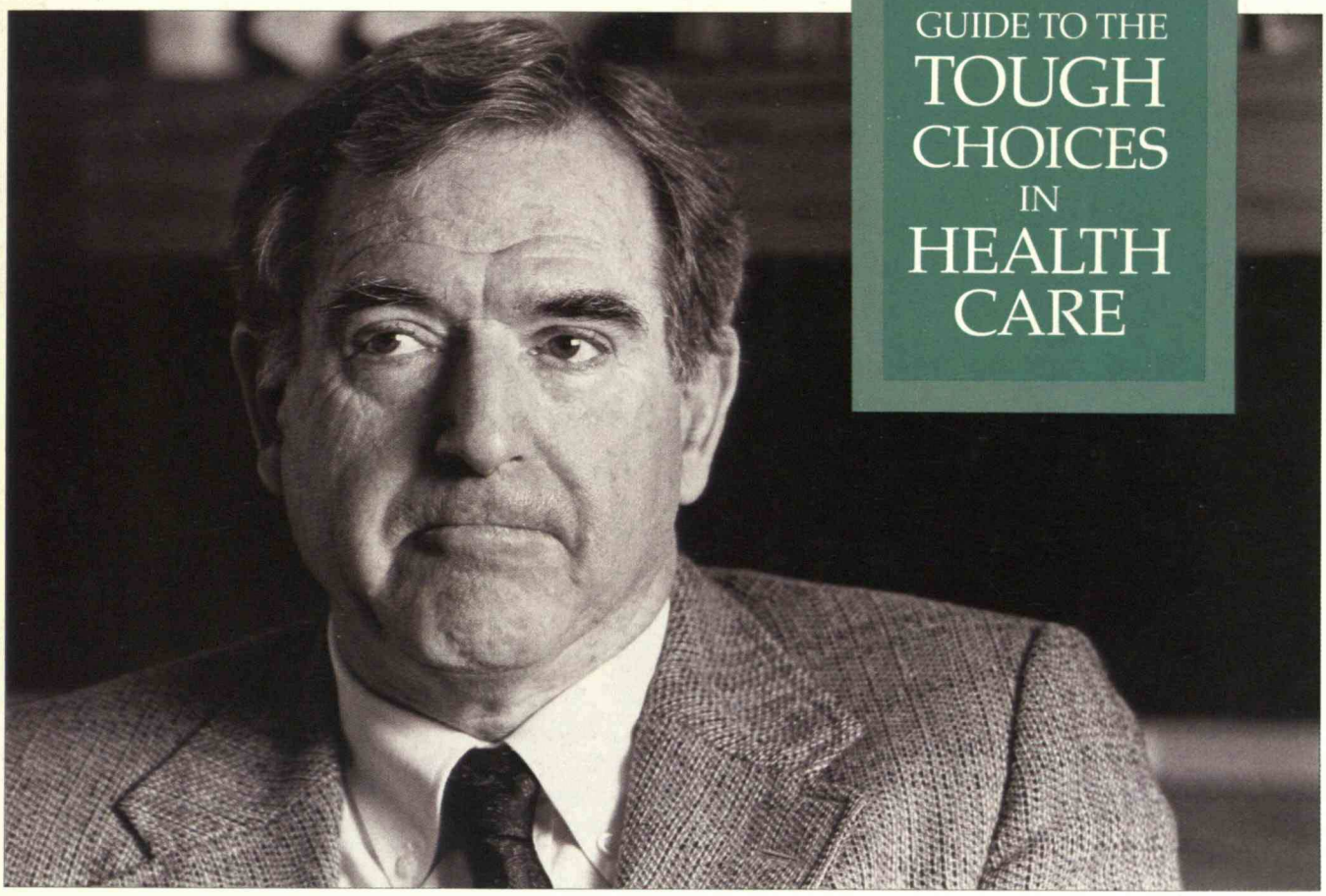

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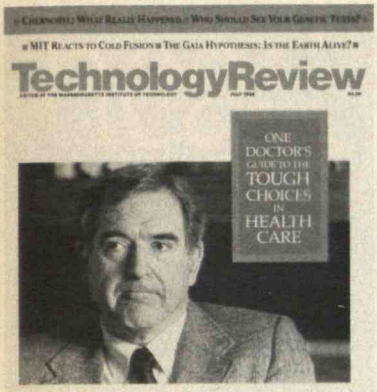

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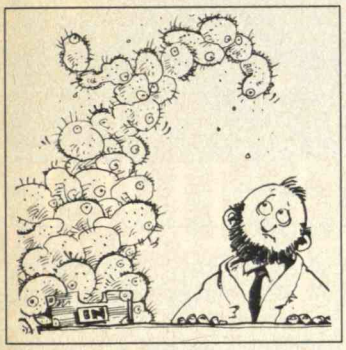

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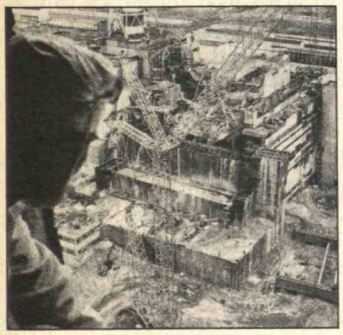

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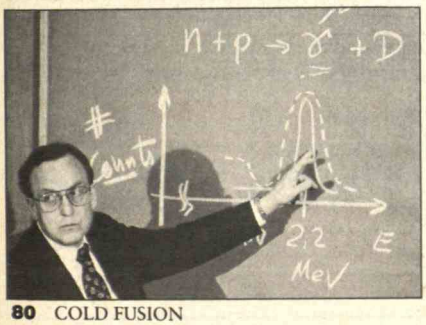

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Renaissance Editor

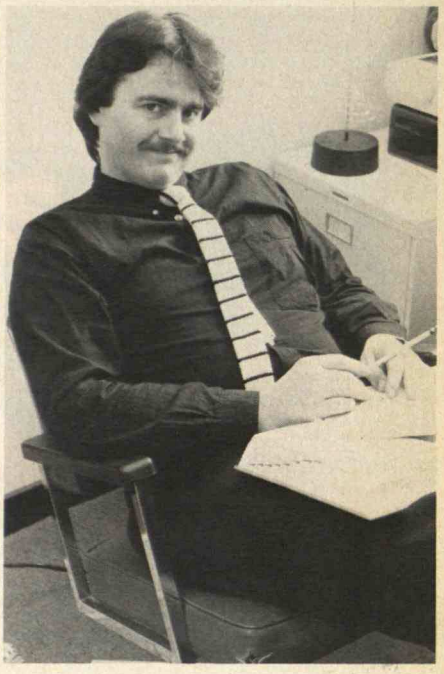
At a recent meeting an editor was describing a proposed article to other members of the staff. It wasn't an easy topic to sum up, and when the editor had explained several of the more straightforward conclusions, he added, "Another theme is that life doesn't always end up as you planned it."

"It's been covered," said David Brittan.

The newest member of the editorial staff, Brittan has been on the masthead for several issues as associate editor. He was also the cover artist for our April issue on stealth technology in the military—the only editor in recent history, at least, to have done such an illustration.

Before working here, Brittan was a contributing editor at *Issues in Science and Technology* and an editor at *High Technology*. He brings to us experience as an editor and writer for the Uses of History Program at the Kennedy School of Government at Harvard University. He did graduate work in musicology at the same university, was an artist in residence at an undergraduate house, and maintains a continued interest in music.

The twists and turns in Brittan's career must have helped shape his intelligent perspective on a broad range of subjects. His sense of humor and care for the details of language and technology contribute substantially to *Technology Review*.



David Brittan

Award Time

Technology Review has won two and a half awards this spring. "Radioactive Waste: Hidden Legacy of the Arms Race," by Robert Alvarez and Arjun Makhijani (*August/September 1988*) received the first annual John Bartlow Martin Award for Public Interest Magazine Journalism. The honor, established by Northwestern University's Medill School of Journalism, aims to "encourage outstanding stories that shed light on the causes, consequences, and remedies of problems in American society." Martin, the journalist for whom the contest was named, wrote in-depth articles about social issues for three decades and was an advisor to Adlai Stevenson, John Kennedy, Robert Kennedy, and Hubert Humphrey.

Contest organizers cited Alvarez and Makhijani's article for "the originality of its reporting and the significance of its impact." The article prompted much of the recent public concern over lax safety and environmental standards in the nation's bomb-making complex. In a followup article in the current issue, John F. Ahearne, former head of the Nuclear Regulatory Commission, looks at how to solve the problems plaguing U.S. defense reactors.

Technology Review also won a 1989 Olive Branch Award for "The Stage Shifts in Arms Control," by Leon Sigal and Jack Mendelsohn (*August/September 1988*). The comprehensive look at the balance of non-nuclear forces in Europe challenged the conventional wisdom that the Soviet Union has a clear advantage. The authors predicted that Mikhail Gorbachev would propose unilateral cuts in those forces, which he did only a few weeks after the article appeared.

Wild Blue Yonder: Money, Politics, and the B-1 Bomber, by Nick Kotz, excerpted in the April 1988 issue, received the Olive Branch Award for a book. The awards, cosponsored by the Editors' Organizing Committee, the Writers' and Publishers' Alliance, and New York University's Center for War, Peace, and the News Media, seek to improve reporting of national-security issues.

Jonathan Schlefer

JONATHAN SCHLEFER

PHOTO: MARGIT BRITTAN

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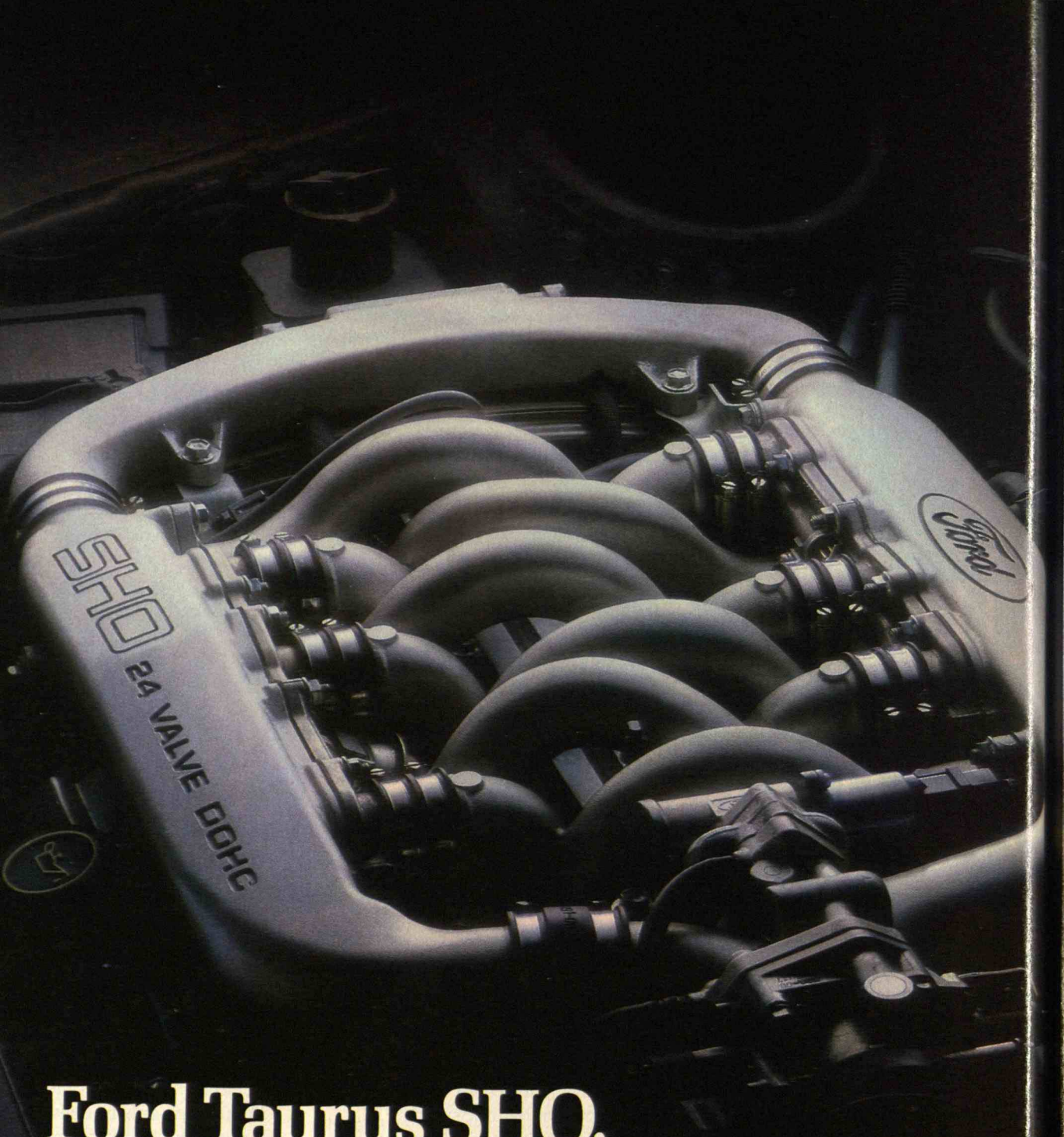

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Exhilarating. Innovative. Exciting. Not the ordinary way to describe a four-door sedan. But the new Ford Taurus SHO is far from an ordinary sedan. Taurus SHO is the end product of Ford's quest to take the American sedan beyond its traditional role of people mover, and into the heady realm of the world class sports sedan. The end result is so compelling that you would seek out its performance even if you didn't need the convenience of four doors.

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Data Follies

FAULTY STATISTICS

I was delighted to see "Distorted Image: How Government Statistics Misrepresent the Economy" by Henry Kelly and Andrew Wycoff *(TR February/March 1989)*. I was in Vienna last spring as the academic representative to a U.N. meeting on the system of national accounts, and I was terribly embarrassed when conferees from other countries asked me why the U.S. accounts are so late and why they are not structured according to international standards. I am asked these questions at each international conference I attend, and I have to admit to my colleagues that the U.S. statistical system is antiquated. During the 1960s and early 1970s, almost all my regional economic research centered on the United States, but now, partly because of inadequate U.S. statistics, my students and I mainly work with data from other countries, such as China, Japan, and Sweden.

I was disappointed that the authors did not indicate what people can do to help alleviate the problem. Staff from the Council of Professional Associations on Federal Statistics (COPAFS) lobby Congress to help maintain and improve data. About 11 organizations already belong to COPAFS, and others can join by writing Katherine K. Wallman, the executive director, at 1429 Duke Street, Suite 402, Alexandria, VA 22314.

Finally, at the January meeting of the American Association for the Advancement of Science, I chaired a session on the use of federal economic and social statistics for scientific research. I am willing to send information about the session to anyone who is interested.

KAREN R. POLENSKE
Cambridge, Mass.

Karen R. Polenske is professor of regional political economy and planning at MIT.

Three years ago, I was a member of a National Urban League task force to develop a pilot paralegal studies program. Projections by the Bureau of Labor Statistics revealed that the paralegal profession would grow rapidly between 1986 and 2000. However, although these projections seemed plausible, we ran into extreme difficulty in trying to obtain good statistics for 1986. One data series indicated that there were about 50,000 paralegals that year, while another revealed that there were over 100,000. A technician at the bureau explained that the tremendous discrepancy was the result of differences in the series' sample sizes. He could not tell us which figure was most accurate. We wound up using information from a paralegal association.

Unfortunately, the lack of coordination that leads to this sort of confusion is not the only problem. Some divisions of government agencies have lost touch with those who use their data. One way to avoid that is to institute partnerships such as the one the National Urban League has developed with the Census Bureau. In a unique joint venture, the league will become a repository of unpublished census data that it will use to analyze the African-American population. This should teach the Census Bureau about the ways segments of society use its information.

Perhaps the Office of Management and Budget should consider such arrangements on a grand scale. The partnership model has no direct costs and contributes tremendously to increasing understanding between the creators and recipients of data.

KENNETH SMALL
New York, N.Y.

In their otherwise excellent article, Kelly and Wycoff are too polite to discuss the intellectual climate behind the U.S. government's failure to adequately modernize and extend its statistical efforts. Look at your newspaper or listen to a ball game and you know that Americans love statistics. That love is not, however, shared by economists, members of the discipline most directly concerned with government statistics. Economists love to play at mathematics; they love new methods for analyzing data. Yet most of them, particularly the influential ones at leading academic institutions, despise data, as is clear from their lack of attention to their quality.

In contrast, gathering sound empirical information is the primary effort of the established sciences. Of course, theory is also essential, but in physics, for example, less than 10 percent of the work is formal mathematics or theoretical analysis.

MARC ROSS
Ann Arbor, Mich.

WAR ADS

I was dismayed to see the advertisement by Lockheed in the February/March *Technology Review*. To me it represents an unfortunate part of the mainstream of American thinking—the attitude that we must spend enormous sums of money preparing for war with an unnamed opponent (the Soviet Union).

We are beginning to realize that while this may be profitable for industries holding Defense Department contracts, it is draining our society economically and politically. I believe it is time to direct our thinking

into other arenas, such as the problems of our own minority groups, the inner city, the slowly eroding living standard, and the decay of our public schools. Beyond these concerns are the troubles of underdeveloped nations, which are beginning to affect our own society. I would like to see companies like Lockheed move into more peaceful and productive pursuits, even if it is temporarily less lucrative.

WALTER CHARLES BRAUN VIII
Greenbelt, Md.

POWER-LINE PERILS

"The Danger of Ignoring Non-Ionizing Radiation" by Louis Slesin (*TR January 1989*) seems to give a lot of credence to the perils of very low-level exposure. However, the evidence is confusing, as the author himself points out. Scientists have no conceptual model of how non-ionizing radiation affects the body, and even though a large number of studies have been conducted both here and abroad, there is a tremendous paucity of experiments that show effects at realistic exposure levels.

Certain prudent, maybe irrational measures are at least harmless: don't put the baby's crib near the wall that carries the wire; don't use an electric blanket if you expect to produce children. Like being careful not to walk under ladders or sit in seat 13 on an airplane (if there is one), these actions are private and usually entail no great cost. But public policy about whether to transport electricity through high-voltage lines or generate it locally should be decided more clearheadedly. After all, the stack gases from oil- or coal-burning plants contain many known carcinogens and acids.

LOUIS D. SMULLIN
Cambridge, Mass.

The author responds:

Superstition is different from scientific uncertainty. Walking around ladders and shunning unlucky numbers should not be equated with avoiding potentially serious health risks.

We may not understand how electromagnetic fields can do damage, but epidemiological studies—based on actual exposures—strongly suggest a link to cancer, notably leukemia and brain tumors. The National Cancer Institute is about to embark on a $2.5 million study of power-line electromagnetic fields, and similar efforts are under way in Europe and Canada. In the meantime, individuals should be encouraged to take simple steps to avoid exposures.

DEALING WITH THE GARBAGE CRISIS

"Making Plastics that Biodegrade" by Ann Gibbons (*TR February/March 1989*) is an interesting and fair article. However, the solution to the garbage crisis lies in enlightened resource management. Not only are degradable plastics expensive and incapable of breaking down completely, but they reinforce our supposed need for endless consumption. Let's unwrap ourselves from excess packaging, create innovative recycling programs, and produce new products from materials that are currently being wasted in landfills.

A.A. THOMAS
Washington, D.C.

Continued on page 76

Retiring a Reactor

What happens when it comes time to close a nuclear plant? The question takes on urgency as the oldest commercial reactors approach the end of their 30-year life expectancy. With the nuclear industry seeking to establish that it can meet this challenge, representatives from plants around the world are watching events unfolding near Pittsburgh, Pa., at the Shippingport Atomic Power Station.

At least 50 nuclear power plants in the West will reach retirement age by the year 2000. Among these, 15 U.S. reactors will be ready for decommissioning, a process that would leave the site safe for other uses, and several are ready for a proven process now. In the long run, the retirement quandary will face all 500 nuclear power plants on-line or under construction worldwide.

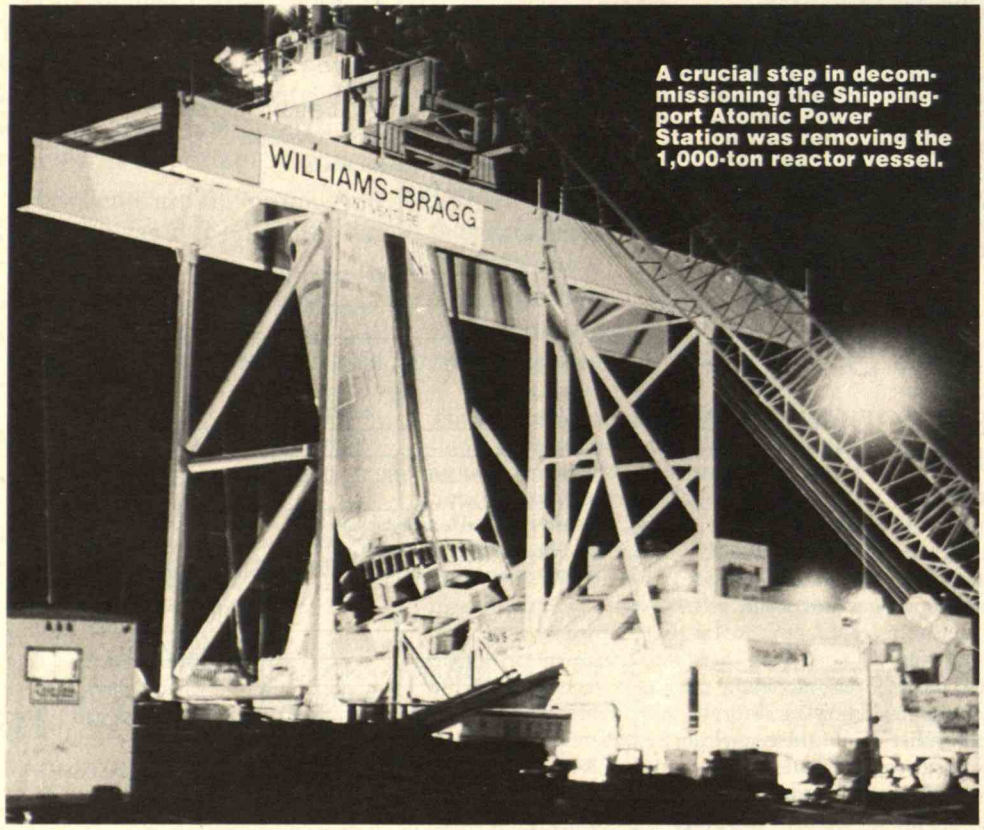
Other nuclear reactors have been shut down, but Shippingport is the first commercial plant to be decommissioned. Thus, the U.S. Department of Energy (DOE) is using this as a model to show that reactors can be torn apart "safely and without danger," according to department representative Dan Butler. But critics like Cynthia Pollack Shea, a Worldwatch Institute decommissioning specialist, say Shippingport's demise "raises more questions than answers."

When Shippingport went on-line in 1957 as a joint venture between the now-defunct Atomic Energy Commission and a private utility, it was the world's first nuclear power plant to operate solely to produce electricity. That historical status underlies DOE's responsibility for the five-year, $98-million decommissioning. Because the 72-megawatt reactor was unprecedented, the government agreed from the outset to handle the decommissioning. Other U.S. commercial facilities are designated to be dismantled by the utilities that operate them.

The Shippingport project appears to be moving smoothly toward its planned 1990 completion. Perhaps the biggest hurdle for a decommissioning is finding a disposal site for a reactor's radioactive remains. The United States currently has no place to discard the extremely radioactive spent fuel rods from commercial reactors. In addition, all three operating sites that accept low-level waste are approaching capacity and, like the reactors themselves, are nearing the end of their lifespans.

To bypass this problem, DOE is burying Shippingport's radioactive debris at the Hanford Military Reservation in Washington State. This spring, the *Paul Bunyan* sailed 7,800 miles carrying the plant's 1,000-ton reactor vessel to the dump. Carrying that load, which was too heavy for long-distance land travel, the barge made its way down the Ohio and Mississippi rivers, into the Gulf of Mexico, through the Panama Canal, and up the Pacific coast.

The reactor vessel's voyage to its earthen burial at Hanford marks the most significant step in dismantling Shippingport. This part of a nuclear power plant is the most cumbersome to discard, and aside from spent fuel rods, it is the most radioactive as well. The rods, like those from all nuclear reactors, currently sit in cooling ponds awaiting the construction of a permanent repository for high-level waste.

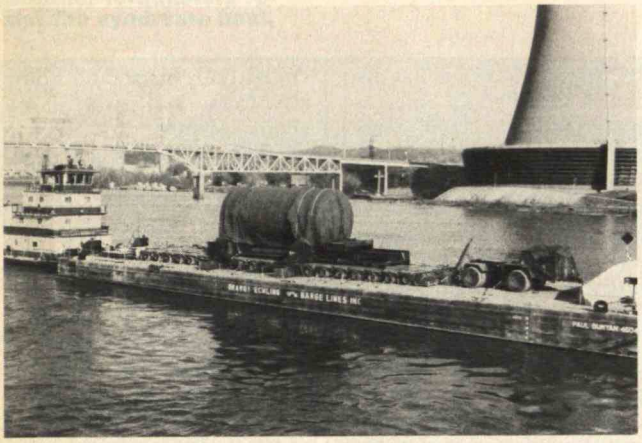


A crucial step in decommissioning the Shippingport Atomic Power Station was removing the 1,000-ton reactor vessel.

Cradle to Grave

Some critics say that the long voyage to the military dump highlights the siting obstacles facing the debris from future decommissionings. While the dismantled remains of a nuclear plant are much less radioactive than the spent fuel, they make up a huge volume of waste. By one estimate, dismantling a standard-sized plant would generate 24,000 cubic yards of radioactive

PHOTO: U.S. DEPARTMENT OF ENERGY



A barge hauled the reactor vessel down the Mississippi River, through the Panama Canal, and up the Pacific Coast to Washington.

waste, four times the volume of the spent fuel from the entire lifespan of the reactor.

Moreover, Shippingport was relatively small compared to the 1,000-megawatt commercial reactors operating today, a factor that could limit the project's relevance. One controversial decision was to remove the reactor vessel intact. Martin Pasqualetti, a decommissioning expert at Arizona State University, says that while it is "a lot cheaper and safer to take the vessel out whole, it doesn't seem feasible for larger reactors." He believes that decommissioning a full-sized commercial reactor would almost certainly require carving the vessel into pieces.

John Schreiber, the department's Shippingport program manager, defends the decision to bury the vessel intact because of the cost savings involved. Cutting the reactor vessel into pieces, he says, would have cost significantly more and exposed workers to more radiation.

But Shea believes that this "means that we are not going to learn anything about the vital remote-control technologies that will be necessary for future efforts." She adds that the result may be higher future costs for utilities forced to use untried techniques.

Such uncertainty fuels discrepancies in the projected costs for taking reactors apart. Estimates range from around $100 million to $3 billion for a single plant. Geoffrey Stevens, head of the Nuclear Development Division for the Organization for Economic Cooperation and Development, puts the typical price at "between 10 and 15 percent of the initial cost of constructing the plant."

Butler insists that while the Shippingport project won't be copied in its entirety, the intention was only to set "a pattern for future decommissioning efforts." He adds that other projects will "surely present new challenges." Karen Wheeless, DOE representative at Hanford, agrees that Shippingport makes an important statement for the nuclear industry, whatever its shortcomings.

Yet Wheeless could be speaking for either side of the debate when she stresses, "You've got to take reactors from the cradle to the grave. If you can't handle the burial, there's some question of whether you should be handling a reactor at all." ■

Seth Shulman has written about nuclear issues for Technology Review, *the* Atlantic, *and* Discover.

The Seasons of Pluto

Of all planets, Pluto is hardest to know. No spacecraft have visited it, so astronomers must glean what they can from earthbound instruments. But at just two-thirds the size of our moon and almost 3 billion miles away, Pluto is just a faint blur through the biggest telescope. Even its mass has been an enigma. In 1840, when Pluto's existence was first predicted, it was guessed to have 12 times the Earth's mass. By 1980, the estimate had fallen to a thousand times less than Earth's mass, leading to an amusing "prediction" that at that rate of decline Pluto would disappear by 1984.

But Pluto did not disappear. Instead, the 1980s have brought fresh insights—and controversy. Some astronomers now think the planet may have an atmosphere and perhaps even seasons. They have surmised this by watching the telescopic blur change as Pluto "interacts" with a distant star, the sun, and Charon, its moon.

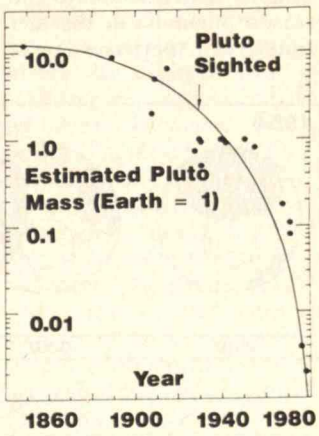
The stellar interaction occurred last June when Pluto passed directly in front of the star. Such "occultations" are a powerful tool: astronomers can gather a good deal of information from watching the starlight switch off and on. In the past, no one had successfully observed a Plutonian occultation because they couldn't accurately predict where they had to be to see it. This time, a specially designed detection system enabled MIT's James Elliot and co-workers to watch from the right place at the right time.

The reward? A hundred seconds of light measurements. From that "light curve," the team observed that the star did not abruptly blink off and on. Instead, it faded and reemerged—as though its light were passing through an atmosphere.

The light curve suggests an atmosphere about 190 miles deep, about twice as deep as Earth's. But Plutonian air would be quite thin: MIT's Stephen Slivan likens it to a "reasonable laboratory vacuum." It could be all methane, a compound detected in Pluto's spectrum, but it could also hold nitrogen, carbon monoxide, or some other material that has escaped detection.

To some astronomers, any sort of atmosphere is surprising. Because Pluto is small, it has little gravity to hold anything. And its temperature could be as low as −388°F, cold enough to freeze most compounds.

To other astronomers, the presence of an atmosphere supports their theory that Pluto varies with the seasons.



Because estimates of Pluto's mass have declined since 1840, astronomers jokingly predicted that the planet would disappear by 1984.

PHOTO: U.S. DEPARTMENT OF ENERGY; CHART: EOS

Indeed, temperature changes could be extreme. When farthest from the sun (aphelion), Pluto is 50 times farther away than Earth is; at its closest (perihelion), it is 30 times as far. Adding to the seasonal effect is Pluto's extreme tilt: it travels its orbit almost lying on its side, such that at perihelion and aphelion the sun is overhead at the equator.

On September 5, Pluto reaches perihelion for the first time in a Plutonian year ago—248 Earth years. It is now the dog days of summer on Pluto, and temperatures could soar to −352°F, high enough to evaporate methane and form an atmosphere. As Pluto heads back toward aphelion, the temperature will drop, and the methane atmosphere will freeze back onto Pluto's surface.

One of the most avid proponents of the theory of seasonal change is Alan Stern of the University of Colorado. He thinks that periodic variations in methane would explain another observation: in 1950, Pluto was 20 percent farther away yet 30 percent brighter than it is today. The reason might lie in the fact that fresh methane ice is bright white, but it converts to dark compounds such as ethane, propane, or graphite when exposed to cosmic rays or the sun's ultraviolet rays. As Pluto nears the sun, methane could evaporate and leave the darker compounds behind. Pluto would appear dimmer, until the cold weather returns and methane once again forms a frosty surface layer.

How Big?

By studying another once-in-a-lifetime event, this one involving Pluto and Charon, MIT's Richard Binzel is finding other evidence of seasonal change. In 1985, terrestrial observers began to see Charon and Pluto passing in front of one another. Such "mutual eclipses" happen every 3.2 days during a five-year period that occurs once every 124 years.

Unable to see Pluto and Charon separately, Binzel compares the color of the total light when Charon is visible and when it is eclipsed. He concludes that Pluto is redder than Charon, perhaps indicating that the planet is covered by methane, its moon by frozen water. He has also found that Pluto's poles are bluer than its equator. Methane is blue when fresh, red when old. Therefore, he reasons that Pluto has newly deposited methane on its poles, where the sun's rays now hit at a glancing angle.

But Marc Buie of the Space Telescope Institute in Baltimore doubts that seasons alone can explain Pluto's dimming. He believes a more important factor may be our change in perspective. In the 1950s we viewed Pluto pole-on; now we are looking equator-on. Since the poles are bright and the equator dark, that change would make Pluto appear to dim.

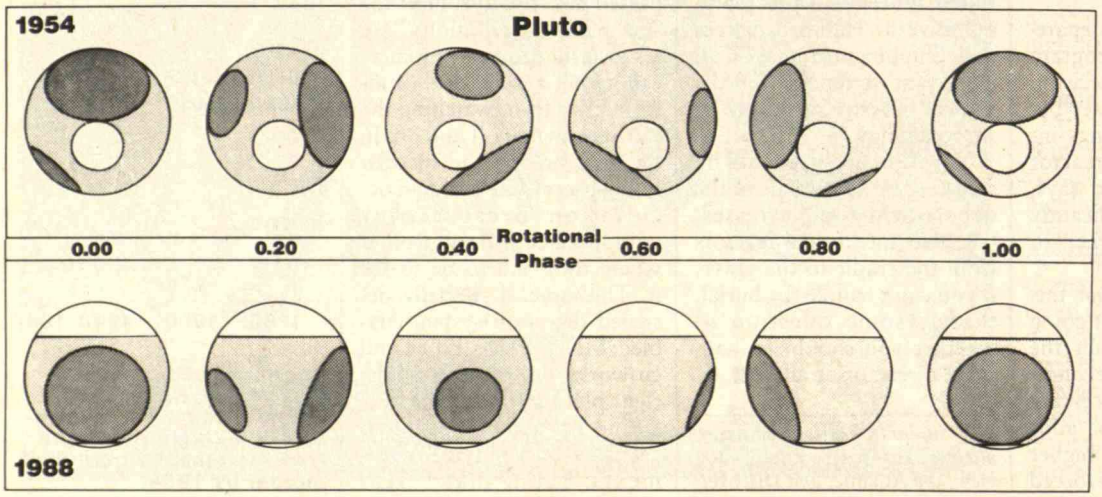
Aided by a supercomputer, Buie has created a possible map of Pluto's surface. By placing bright polar caps, plus a light and a dark patch, on the surface, the computer produced the orbital light curve of the past 30 years. Assuming that the polar caps are permanent, there's no need to invoke seasonal changes.

As researchers grapple over the nature of the planet's surface, an even more fundamental question remains unanswered: how big is Pluto? Both Binzel and Elliot have observed a radius of about 750 miles. But that figure is uncertain: are the astronomers viewing Pluto's edge or the point at which the atmosphere becomes too dense to see through?

Several upcoming events should help clarify such controversies. During the next year, Charon will traverse the last of Pluto's surface. According to Buie, that final bit of data may settle whether seasonal change is important.

The Hubble Space Telescope might also yield answers. Scheduled for launch in December, this orbiting telescope could deliver pictures clear enough to show any major bright or dark patches, such as those in Buie's computer model. It will also carry an ultraviolet spectroscope able to detect nitrogen and carbon monoxide gases. Finding much of either could settle the argument about seasons: the temperature of such an atmosphere wouldn't vary. ■

NANCY W. STAUFFER is a free-lance science writer and the editor at MIT's Energy Laboratory.



Pluto has dimmed since 1954, and some researchers say the explanation might lie in the position of light and dark patches on its surface. The diagrams show hypothetical patches during Plutonian days in 1954 and 1988.

CHART: ROBERT MARCIALIS

Overconfidence plagues all kinds of experts. Race handicappers and weather forecasters resist the syndrome best.

The Dangers of Overconfidence

The explosion of the space shuttle *Challenger* should not have surprised anyone familiar with the history of booster rockets—1 failure in every 57 firings. Yet less than a year before the disaster, NASA set the chance of an accident at 1 in 100,000. That optimism is far from unusual: all kinds of experts, from nuclear engineers to physicians, tend to be overconfident.

For a decade and a half, psychologists have been uncovering the prevalence and causes of unwarranted confidence. At the same time, the researchers are revealing ways to lessen its dangers.

A pioneer in this work is Erik Vanmarcke, an engineer now at Princeton University. In 1974, he asked seven renowned engineers from private industry and academia to predict the height at which a dirt embankment would collapse under its own weight. He requested a span of estimates that would represent a reasonable margin of error. Some engineers came up with quick answers "after half a day of back-of-the-envelope calculation," says Vanmarcke. "Others spent tens of thousands of dollars in company money doing rather fancy analyses."

The correct answer was later determined at an MIT symposium attended by the engineers. A bulldozer piled dirt on the embankment until it gave way. The result: not only were all the answers wrong, but none of the ranges of estimates included the right height.

Other experiments have since revealed widespread expert chutzpah. Doctors and clinical psychologists often place more credence in their diagnoses than is justified. Even physicists, who take pains to analyze sources of error, are too confident. Across all disciplines, says Carnegie Mellon University psychologist Baruch Fischoff, "the basic effect is really insensitivity to how much one knows."

The same blind spot affects lay people. In 1977, Fischoff and his colleagues gave nonexperts a general-knowledge quiz, asking, for example, "Is absinthe (a) a precious stone or (b) a liqueur?" More important, the subjects had to guess the probability that they were right. Even people who felt 100 percent right were wrong as often as 30 percent of the time.

Handicapping—setting the betting odds for a contest—is among the surprisingly few occupations that supplies the right conditions for reducing overconfidence. In 1976, Jack Dowie, a decision theorist at the Open University in England, found that professional horse-race handicappers are "well-calibrated," or accurate in their predictions. Handicappers don't always pick winners, but when they say a horse will win one race in four, they know whereof they speak.

One reason, says Dowie, is that handicappers get "feedback race after race, day after day." Furthermore, handicappers are paid for good calibration. "People learn how to do things if they get prompt, unambiguous feedback" and are rewarded for accuracy, Fischoff notes.

Weather forecasting is perhaps the only other field that can boast of well-calibrated expertise. According to Oregon State University atmospheric scientist Allan Murphy, rain forecasts are excellent. For one thing, meteorologists have answered the same question daily for decades. And the feedback couldn't be clearer—it rains or it doesn't. Finally, "weather forecasts don't affect the weather," Murphy notes. By comparison, a stock-market analysis can alter investor behavior.

One important source of overconfidence may be a simple mental quirk. Fischoff believes that once a possible answer comes to mind, a subconscious juggernaut develops: more and more supporting facts are remembered, while contrary facts are ignored. It's more natural "to think of consistent rather than inconsistent thoughts," he says.

To test this theory, in 1980 Fischoff and his colleagues Asher Koriat and Sarah Lichtenstein had people explain

PHOTO: ALICE GARIK, PETER ARNOLD, INC.

why their answers to a set of questions might be wrong. Only then did the team ask these subjects to estimate the chance that the answers were correct. The result? Reduced confidence, which suggests that forcing people to consider contrary evidence could bring them back down to earth.

Another source of trouble, says Fischoff, is that "people exaggerate how completely they've been able to identify the factors that are relevant." He showed people several lists of reasons why a car might not start. Whatever the length of the list, people generally judged it complete. "Things that are out of sight tend to be out of mind," he observes.

Fischoff thinks that this can affect engineers who list failure conditions—called fault trees—for complex technologies such as nuclear reactors, despite the high stakes. He cites a Nuclear Regulatory Commission study of reactor safety completed four years before the 1979 near-meltdown at Three Mile Island. Even before that accident, the commission's own critical reanalysis of the report found it had overstated its precision about the chance of a catastrophic failure by a factor of at least 1,000.

But professional hubris may sometimes be hard to correct, given that feedback is not always available. Fischoff cautions that assessments of any novel technology are inherently suspect. "If you've got engineers who are telling you how safe a new kind of complex technical system is . . . you have to figure that they're just guessing." ■

JOHN RUBIN is a free-lance writer specializing in psychology. He holds a PhD in cognitive science from MIT.

Megacities

Many New Yorkers are convinced that their city, with its potholes, homeless population, and drug and health problems, is "New Calcutta," as the *New York Times* recently dubbed it. The United Nations has confirmed this judgment.

In 1986, Ellen Brennan, a Latin American historian and policy analyst at the U.N., prepared the first of a series on "megacities." The world's largest cities, these will each be home to over 10 million people by the year 2000. To date, she has looked at 10 cities, among them Delhi (now over 6 million), Seoul (9 million), Calcutta (11 million), Bangkok (5 million), and Manila (6 million). A few of the cities still to come on her list are Cairo (13 million), Mexico City (17 million), Beijing (9 million)—and eventually New York (8 million).

Increasingly, megacities are a Third World phenomenon. In 1980, 5 of the 8 megacities were in developing countries. With urban centers in these nations doubling in size over the next 20 years, 19 of 25 megacities will soon be in the Third World. Most often, the great bulk of residents are very poor, living in shantytowns on the periphery.

For New Yorkers seeking a bit of insight on the future of the Empire City, Brennan finds many parallels between their home and its Third World relatives. Like New York, many megacities are former colonial cities, but colonists usually "picked the wrong location for a city of this size," exacerbating modern problems like air pollution. And decaying infrastructures—water mains, waste disposal, shelter, bridges, and roads—"have become woefully inadequate," says Brennan. "In New York and elsewhere, there's little money to do more than patch things up." There is even another "long, skinny island" plagued with traffic congestion—Bombay.

New York City suffers from many of the same problems faced by megacities in the Third World.

And other megacities are no strangers to New York's worst dilemmas. Karachi has a drug-abuse program to cope with heroin addiction, while AIDS afflicts Mexico City, Sao Paulo, Rio de Janeiro, Bangkok, and Manila.

The major resemblance between New York and other megacities is its inefficient use of land. Referring to Harlem and parts of the south Bronx, Brennan notes "acre after acre of empty land so close to the center of Manhattan." She maintains that available property is just as scarce in the center of cities like Delhi and Karachi, where up to 80 percent of land is publicly owned. And the same phenomenon characterizes Bangkok, Manila, and Seoul, where most is in private hands.

Like its sisters, New York is monocentric: workers com-

PHOTO: KEITH GLASGOW

mute to one central district. Brennan believes that promoting "a more polycentric metropolitan pattern" would make sense in many cities. Thus, low-income residents on the periphery wouldn't be cut off from jobs.

Two-Cent Subway Fares

Some Third World cities have made astonishing progress. Seoul has reclaimed land along its river banks, modernized its sewage system, and built new bridges. And Calcutta, although still one of the world's poorest cities, has made headway on seemingly intractable problems. Chlorination has dramatically reduced cholera, and "access to water is now better than in most large Indian cities," says Brennan.

But even innovative megacity managers are handicapped by lack of data—a problem technology can ameliorate. High-resolution satellite photos yield better maps and more accurate counts of people and empty lots. Because this information is invaluable to planners, Bangkok hired graduate students to pore over a sequence of aerial photos and count various types of buildings. The students fed the figures into a computer, producing a detailed study of changes in housing.

Another stumbling block for most Third World planners is their Western training. They tend to favor rigid master plans for growth, which assume the European pattern of slow change. "Some of the early population projections for Third World cities were so low they're hilarious," Brennan says. "A Swedish consulting firm put Karachi's population at 3 million by the end of the century. Actually, it will be 12.5 million."

One attraction of megacities is subsidized services like energy and subways. "In some cities, prices are ridiculously low," Brennan points out. "The Mexico City subway costs about two cents." She believes that with higher fares or fees for water or fuel, cities could modernize their infrastructures and serve more people. But residents are firmly wedded to subsidies: over 300 people died in riots this year after Venezuela raised fuel prices from 16 cents to 26 cents per gallon and equally inexpensive public-transport fares 30 to 50 percent.

Even if the public could accept higher prices, "it's very hard to convince planners they're being short-sighted," says Brennan. "They want to look like the West." Cairo's subway, part of a master plan, opened in 1987 with only five stations and one north-south line. Brennan thinks altering traffic patterns would have been cheaper.

Finally, what works in the Third World might fail in New York. "I think Seoul is an incredible success, but that's partly because it reflects a homogeneous, disciplined society and an expanding national economy," Brennan remarks. "Its methods may not necessarily help New York, which is more heterogeneous."

In any case, city managers need data, so demand is heavy for Brennan's studies, which will become part of a U.N. database on the world's 100 largest cities. And to encourage managers "to do the best they can, given their resources," the United Nations will host a meeting on megacities next year in Tokyo.■

ANN MARIE CUNNINGHAM is a native New Yorker who has no plans to move away.

Red Tidings

Last October, a woman became ill after eating Puget Sound shellfish. Washington State officials quickly banned shellfish harvests in the area, and stores in seven states removed such food from shelves. The cause of this swift action was an outbreak of the infamous red tide.

In Florida, several groups of researchers are uncovering a great deal about the tiny organisms that turn infested waters reddish or rusty. However, there is little agreement on what—if anything—should be done to prevent outbreaks.

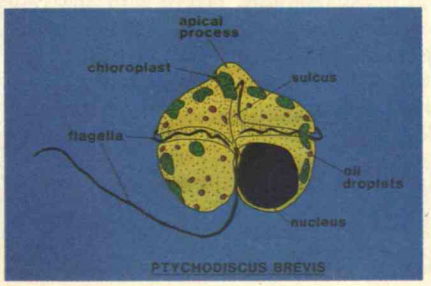
The culprits are dinoflagellates, single-cell plants that are a variety of plankton. Although many dinoflagellates are harmless, about 30 types can synthesize nerve toxins. A single species can produce "as many as eight different toxins," notes Richard Pierce, a marine chemist at Mote Marine Laboratory in Florida.

"Exactly what the purpose is for these toxins is not known," says Pierce. But coastal residents do know that a red tide can exact tremendous costs. Clams, oysters, mussels, and other shellfish concentrate neurotoxins in their tissues as they ingest red-tide microorganisms. The toxin doesn't hurt the shellfish, but it can kill people who eat them. Moreover, red tide can lead to massive fish kills, because it is toxic and depletes oxygen from the water.

The economic aftershocks can hit tourism and shellfishing especially hard. According to the most recent major study, conducted in 1975, each Florida bloom cost the tourist industry $15 million to $18 million. Shoreline cleanups added another $2 million.

In view of these consequences, researchers at the Florida Department of Natural Resources (FDNR) are investigating the conditions that initiate red tides. Certain nutrients seem important, and these may be delivered by currents upwelling over the continental shelf. To test that theory, Vi Stewart of FDNR says scientists at their Florida Marine Research Institute examine satellite images. "We are trying to correlate [the currents] with red-tide outbreaks," she explains.

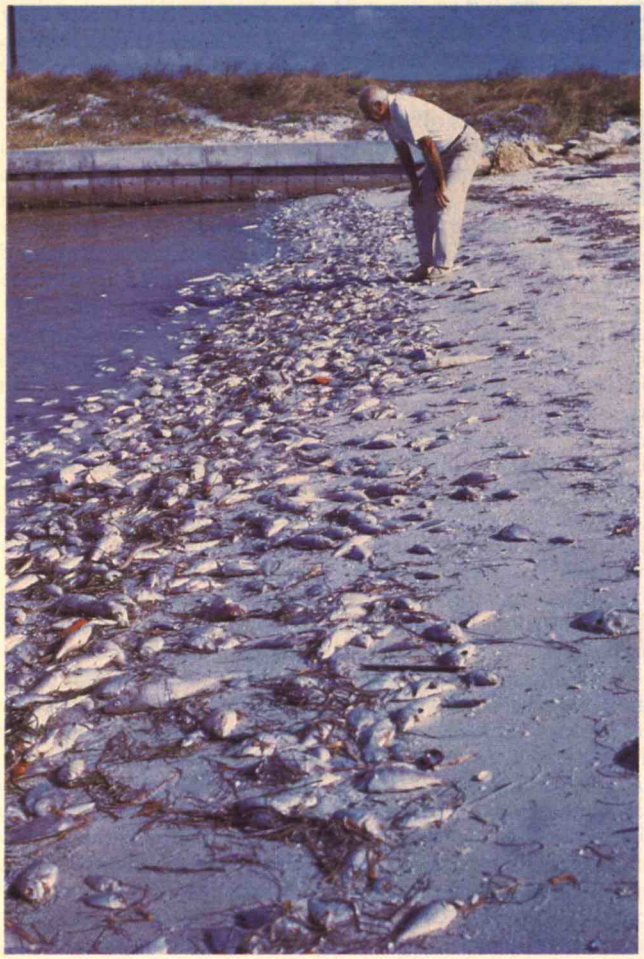
At the Mote Laboratory, Pierce and his colleagues focus on the chemistry and effects of red-tide toxins, including those in ocean spray. They are comparing their findings to hospital records on respiratory illness, because even people who don't eat contaminated shellfish may be affected. As waves crash upon the shore, the dinoflagellates burst open, releasing toxins into the air.



This tiny marine alga is responsible for Florida's red tides. When the cell membrane breaks, the toxins that are released kill fish, contaminate shellfish, and irritate human respiratory systems.

ILLUSTRATION: MOTE MARINE LABORATORY

Red tide is a natural event, so while outbreaks can damage tourism and shellfishing, not everyone thinks they should be prevented.



People and animals who inhale the toxins can suffer temporary respiratory irritations, including runny noses, watery eyes, and coughing.

To Control or Not to Control

Chemist Dean Martin at the University of South Florida's Center for Chemical and Environmental Management Services is going a step farther. He is searching for ways to turn back a red tide.

Earlier attempts at control relied on spraying copper sulfate from crop-dusting planes. But copper sulfate harms many beneficial organisms and can upset a coastal ecosystem. Further, copper sulfate inhibits red tides only temporarily.

Martin has found two natural biochemicals that may do a better job. Both derive from nannochloris, a microscopic alga. One chemical, aponin, reacts with the cell walls of dinoflagellates, making them swell and burst. This destroys the organism but also releases the toxins into the air. The second biochemical, as yet unnamed, overcomes that drawback, shrinking red-tide organisms and forcing them into their normal resting state.

But not everyone advocates managing all red-tide outbreaks. Although noxious, the blooms are natural phenomena throughout the world. Charles Darwin noted an outbreak off the coast of Chile during his voyage aboard the *HMS Beagle* in 1835. And in the Bible, one of the plagues inflicted on Egypt may have been red tide: "and all the waters that were in the river turned to blood."

"We don't look for control," says FDNR's Stewart, noting that the plankton in red tide are "at the base of the food chain in the gulf." In fact, Martin believes that Florida environmental officials ignore control measures because they view red tide as a natural disaster, similar to a forest fire, which is essential to the ecosystem.

Stewart suggests that cost is another important factor when contemplating control. Florida red tides begin 10 to 40 miles offshore and can span 14,000 square miles of ocean. "You can follow the implications of treating so vast an area," she says. Pierce concurs: "We must be realistic and realize what an extensive effort that would take." He adds that until more is known about red tide, "I don't think it is our place to go out and control it."

However, Pierce acknowledges that "control within localized environments" may be necessary, especially where fish are grown for food. Martin points out that "our view of forest fires depends on where our homes are relative to the fire." Red tide would have a chilling effect on aquaculture "if every third year your investment would be wiped out." ■

MICHAEL ROOT is a research chemist and free-lance writer in Madison, Wis.

Making Medical Labs Measure Up

To ensure the accuracy of the 4 to 6 billion medical tests performed annually, Congress enacted the Clinical Laboratory Improvement Amendment (CLIA) last year. Beginning in 1990, the Health Care Financing Administration (HCFA) will set standards for staffing and maintaining medical labs. HCFA will also manage a comprehensive program to police the facilities, imposing sanctions on those that don't measure up.

But while labs will have to prove their mettle, many experts in laboratory medicine voice apprehension about the proposed certification program. In particular, the primary methodology for checking on labs may itself be flawed.

Few people argue against the need to regulate medical labs strictly. A 1987 Pulitzer-prize-winning series in the *Wall Street Journal* chronicled widespread inaccuracies and fraud in the field—a theme echoed in many other reports and at 1988 congressional hearings.

The need for oversight has mushroomed with the advent of microprocessors, which have enabled manufacturers to develop compact, less-expensive instruments. With these, physicians can perform some tests in their own offices, so patients don't need to visit a separate lab to leave urine and blood samples. And doctors can get readings without waiting days.

PHOTO: MOTE MARINE LABORATORY

A new federal law aims to ensure the accuracy of medical tests. Yet the procedures it relies on may be flawed themselves.

As a result, physician-office labs are increasing at a rate of 16 percent each year, according to the Department of Health and Human Services. Doctors' offices now perform about a fourth of U.S. medical tests, while 12,000 to 14,000 hospital and clinical labs handle the rest.

Yet until the CLIA, federal regulations covered only labs that transported samples between states and those performing tests billed to Medicaid and Medicare. Federal and most state guidelines touched few of the estimated 98,000 physician labs.

Unfortunately, those facilities are not always staffed by medical technologists, while general practitioners "by and large do not have the training to deal with the pitfalls of testing," says Jocelyn Hicks, chair of laboratory medicine at Children's Hospital National Medical Center in Washington, D.C. "There are a lot of subtleties with analysis, and doctors don't have experience with those subtleties."

To document the situation, Daniel Kurtycz, chief of cytology at the University of Wisconsin Medical Center, studied Wisconsin physician labs for three years. "Some procedures were shocking," he says, citing records stored in shoeboxes and pressured staff who reported wrong results. According to Kurtycz, at times offices skipped basic steps, including some meant to ensure that samples are obtained correctly or that instruments are properly calibrated.

Testing the Testers

While the CLIA addresses the lack of regulation for physician labs, it also opens up questions about how exactly to assure quality testing.

Currently, the College of American Pathologists (CAP), the American Association of Bioanalysts (AAB), and agencies in three states provide "proficiency testing" (PT) services for hospital and clinical labs. They mail samples to the labs for analysis, and the results are matched against target scores.

Under the CLIA, the number of labs that will need PT services to be certified could expand 10-fold. "The logistics of this are overwhelming," says pathologist John Rippey, chair of the CAP survey committee. In fact, no one knows how many offices will need testing. On the one hand, the law covers any type of medical lab—including mobile cholesterol-testing units in shopping malls. On the other hand, CLIA excludes most low-tech tests, so some physicians' labs may be exempt.

Nicholas Serafy, director of the AAB service, adds that HCFA guidelines will likely require low-scorers to join extended checking programs. This means still more testing. CAP expects that 25 to 30 percent of U.S. labs will need to enter such programs.

Not only might the regulations strain the lab-testers' capacity, but Rippey suggests that the certification procedure is unsatisfactory in itself. Labs know when a sample will be graded, so they score better on tests than in daily practice. Blind checks might indicate reliability better—but the logistics of using real samples, getting doctors' permission, and other problems make it nearly impossible to institute them.

Even the technology is suspect. To maintain their stability in the mail, most PT samples are freeze-dried. Some samples "can get too cold or too hot in shipment," skewing the results, Rippey points out. And many instruments require whole blood, which tends to score poorly. While such results can be graded on a sliding scale, widespread physician-office testing will place pressure on manufacturers since equipment that performs well on freeze-dried blood tends to score poorly on whole patient samples. Daniel Tholen, a senior biostatistician with CAP, says he is aware of an instrument designed to do well in proficiency tests—but it may be less accurate reading a real sample.

Nevertheless, even a cautionary like Rippey thinks PT "can be a useful trigger for further inquiries." AAB associate administrator Mark Birenbaum agrees, saying it "is the best external source for determining lab quality that is economically feasible." According to Birenbaum, PT should be part of the regulatory system—along with well-managed regulatory agencies, a well-designed inspection program, and standards that would ensure adequate lab staffing. ■

TOM KIELY is a free-lance writer specializing in medicine and business.

PHOTO: WEYMOUTH DESIGN

MINI • TRENDS

DELETED JOKES

Stanford's Computer Science Department has unanimously protested the decision of university administrators to delete a database containing more than 1,000 jokes. The file of jokes, some of which could be considered objectionable, was removed from computers controlled by the Stanford Data Center and Academic Information Resources. The department statement charges that removing a possibly offensive file from a computer is no different from censoring a library book.

A programmer in Waterloo, Ontario, compiles the database and transmits it to most universities and many companies through the UNIX operating system. The programmer encrypts jokes that he thinks are objectionable, so they can be read only by those who decode them. An MIT graduate student triggered the controversy when he protested against an unencrypted joke he considered anti-Semitic.

ECOLOGY ARCHIVE

Where substances in the environment end up, how they affect people, and what kind of changes they go through are but a few of the questions chemists and toxicologists will continue to tackle into the next century. To aid their work, the West German government is funding the Environmental Sample Data Bank. Among the many institutions participating in the project, the Federal Environmental Control Agency is maintaining a collection of human blood, liver tissue, urine, fatty tissue, and hair, all stored in a walk-in deep freezer at −121°F.

The object is to learn about the behavior of the more than 100,000 chemical substances that humankind has generated thus far, with thousands more being developed annually. The collection, started in 1985, now contains 250,000 samples. About 5,000 more are added every year.

COPY FREE

The software industry wants Congress to close a legal loophole that allows state universities and agencies to make free duplicates of copyrighted computer programs. Software firms worry that the Supreme Court's recent *BV Engineering* decision will result in widespread unauthorized copying.

BV Engineering had sued the University of California at Los Angeles for making three copies of each of seven electrical-engineering programs purchased from the firm. UCLA had also made 10 copies of the user manuals. According to *Computerworld* magazine, the Supreme Court ruled that the Eleventh Amendment to the Constitution, which grants state governments immunity from certain lawsuits, protects public universities.

JOB MACHINE

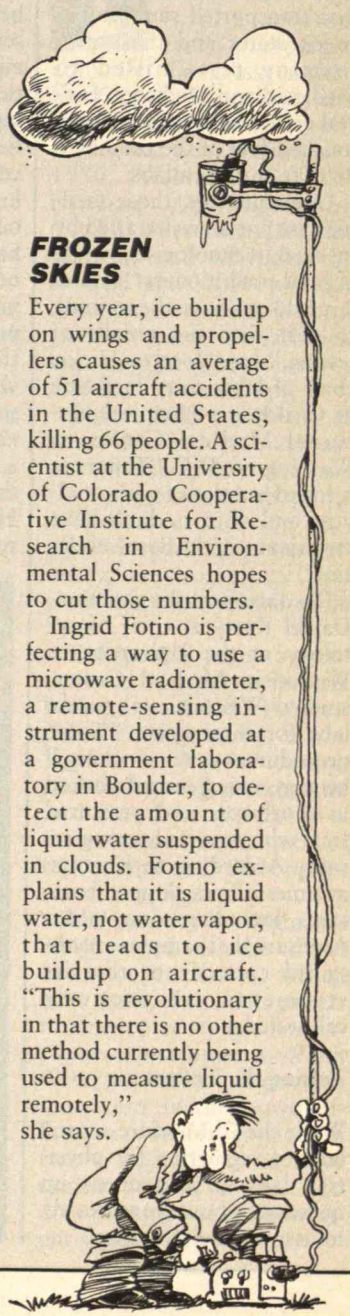
While Americans look to the Pacific Rim and Western Europe for economic solutions, others find answers here. The Organisation for Economic Co-operation and Development (OECD) has just released *Mechanisms for Job Creation: Lessons from the United States.*

According to the OECD, "the 'great American job machine' has made it possible to create 30 million new jobs during the last 15 years." The 230-page book cites such factors as "a surge of new initiatives, a genuine spirit of enterprise, the readiness of both public and private actors to be partners in development, and active intervention by governments, towns, universities, employers, and local communities."

MORE R&D $$

Scientists want the federal government to invest more in civilian research. When *Research & Development* magazine asked some of them what advice they would give the Bush administration, 56 percent replied that Washington spends too much on military research.

Of 264 top researchers polled, 86 percent favor an average 10 percent increase in government-sponsored civilian research. Almost two-thirds—65 percent—gave top priority to research on high-temperature superconductivity. AIDS research ranked a close second, with 63 percent favoring more funding. To pay for these programs, the scientists would cut military R&D and raise federal cigarette and liquor taxes. A strong majority also would boost tax credits for private R&D.



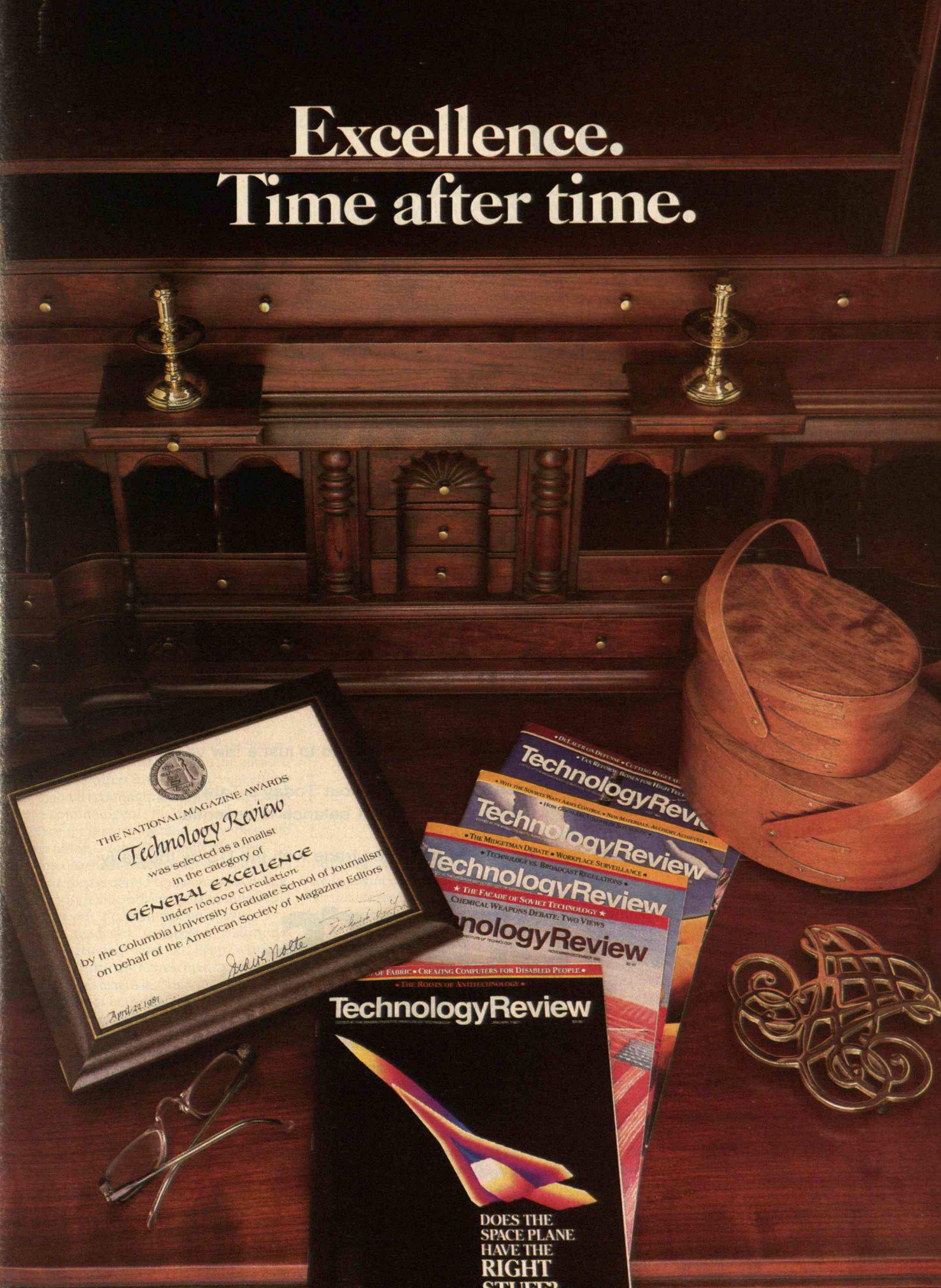
FROZEN SKIES

Every year, ice buildup on wings and propellers causes an average of 51 aircraft accidents in the United States, killing 66 people. A scientist at the University of Colorado Cooperative Institute for Research in Environmental Sciences hopes to cut those numbers.

Ingrid Fotino is perfecting a way to use a microwave radiometer, a remote-sensing instrument developed at a government laboratory in Boulder, to detect the amount of liquid water suspended in clouds. Fotino explains that it is liquid water, not water vapor, that leads to ice buildup on aircraft. "This is revolutionary in that there is no other method currently being used to measure liquid remotely," she says.

ILLUSTRATIONS: JON McINTOSH

Excellence.
Time after time.



WHO REDUCED ITS TRADE SURPLUS WITH THE US BY OVER 35% IN 1988?

WHICH COUNTRY SENT 14 "BUY AMERICAN" PURCHASING MISSIONS TO THE US, PURCHASING OVER $11 BILLION WORTH OF US GOODS.... AND TO SEND EVEN MORE?

PLANS

WHICH US TRADING PARTNER REDUCED 4,800 TARIFFS IN 1988, TOWARD TRADE?

BALANCED

WHICH COUNTRY INCREASED ITS IMPORTS OF AUTOS BY 250% IN 1988?

U.S.

SINCE SEPTEMBER 1985 TILL NOW, WHICH COUNTRY'S CURRENCY HAS RISEN 50% AGAINST THE US DOLLAR TO HELP BALANCE

TRADE?

So dramatic is the difference — even when compared to just a few years ago.
So accelerated are the accomplishments —
even the well-informed are surprised by the facts about Today's Taiwan.
As a trading partner, today's Taiwan realizes that balance is essential.
Toward that end, much has been done.
More will be done to achieve the goal of balanced trade with the US by the early 1990's.

TODAY'S TAIWAN

REPUBLIC OF CHINA

If you would like to know more about Today's Taiwan, please see the June 26 issue of TIME (Top Management) or Business Week (NY/DC/CHI/CAL)

BENNETT HARRISON

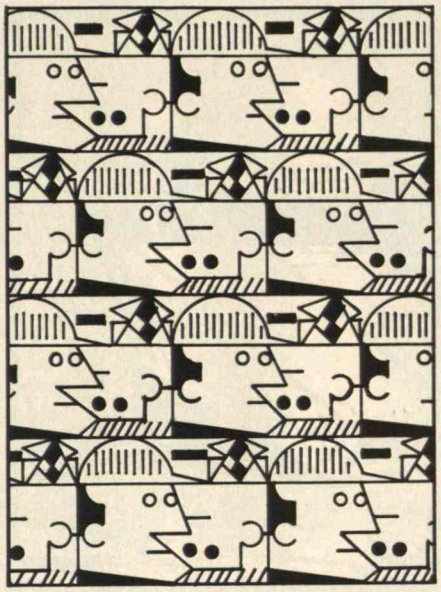
When Workers Become Entrepreneurs

Pittsburgh. At first glance, the economy of western Pennsylvania seems to tell an all too familiar story of unbalanced and inequitable growth. Fueled by Fortune-500 headquarters, a growing medical complex, and world-class research universities, the service economy of Pittsburgh is booming. Meanwhile, the traditional steel towns in the "Mon Valley," downriver from Pittsburgh along the Monongahela River, are bearing the brunt of deindustrialization and economic dislocation. Between 1977 and 1982, shrinking steel firms laid off about 100,000 workers in the tri-state region of western Pennsylvania, eastern Ohio, and northern West Virginia. Local officials estimate that there are still 25,000 to 30,000 former industrial workers out of work in the Mon Valley alone.

But such a picture obscures a far more interesting and hopeful story. Today, the steel towns of the Mon Valley and the city of Pittsburgh are participating in a unique experiment in regional economic development. Municipal governments, community organizations, locals of the United Steelworkers union, and some small entrepreneurs have joined in a quasi-public agency known as the Steel Valley Authority (SVA). The intention is to prevent the region's manufacturing base from eroding further and, where feasible, to create new industrial enterprises.

The SVA (in the interests of full disclosure, I should mention that I serve on the authority's board) differs from most current efforts at regional economic development. It insists on a continuing role for basic industry and a place at the planning table for workers and their unions. Too often, state initiatives focus on new high-tech and service industries at the expense of traditional manufacturing. And most public-private "partnerships" tend to leave out a crucial partner: labor.

This tendency to neglect traditional manufacturing and to keep workers (whether formally represented by unions or not) at arm's length is a mistake, and not just for reasons of fairness. Competitive, world-class manufacturing firms remain a crucial component of a stable economy. And technological modernization requires the active involvement of the workforce. Workers often know as much about what constitutes "appropriate" technology for performing a task as do engineers or managers. It is a waste of a valuable resource to exclude them from the planning process.



An innovative agency suggests the importance of worker involvement in regional economic development.

Crafting Economic Alternatives

The SVA is the direct result of workers' efforts to fight the economic destruction of their communities. In response to the mass closings of steel mills in the late 1970s and early 1980s, local officials of the steelworkers union, community organizers, and concerned religious leaders created the Tri-State Conference on Steel. What began as a protest against plant closings soon became a search for concrete economic alternatives. By 1986, Tri-State had convinced the municipal governments in eight Mon Valley steel towns to legally charter the SVA as a quasi-public economic-development agency along the lines of the much larger New York-New Jersey Port Authority. Later, the city of Pittsburgh also joined the authority.

The SVA is funded by the nine city governments and by private foundations. Current and former steelworkers, union officials, and city-government leaders serve on its board. The SVA's full-time staff is small, but the authority draws widely on local experts from the public and private sectors.

Because of its legal status, the authority is empowered to seize closed plants through eminent domain and to float its own bond issues. Although it has never actually seized a plant, its power to do so has helped the SVA get a hearing from a sometimes skeptical business community.

Revitalizing at least some of the region's former steelmaking capacity is high on the SVA's list of priorities. Most promising is a project to create a new steel mini-mill, to be called the South Side Steel of Pittsburgh Co. Authority officials reasoned that, despite the overcapacity of the steel industry, a modernized facility can still find profitable niches. They hired a local engineering firm to prepare a feasibility study for reopening a mini-mill owned by the LTV Corp. The investment house Lazard Frères prepared the business plan. It calls for the authority to modernize the furnaces so they can turn a profit at a smaller volume. It also recommends introducing new technologies for flexible continuous casting, which will allow the mill to turn out slabs of different sizes and shapes to suit a variety of customers.

LTV has recently agreed to sell the closed mini-mill—on the condition that the authority come up with the roughly $120 million in financing necessary to purchase and modernize it. SVA officials are putting together a package of loans from public and private sources, including federal, state, and local governments, steel-equipment vendors, and potential customers. Like the extremely successful Weirton Steel Co. in neighboring West Virginia, South Side Steel will be owned by the workers.

The SVA has already hired a 30-year veteran of the steel industry to head the revived mill. At full capacity, the company is expected to employ up to 400 workers. If successful, the mill may even expand into fabricating steel products from the slabs that it casts.

Meanwhile, the Basic Metals Processing Research Institute at the University of Pittsburgh has commissioned the SVA to explore the idea of restarting a "plate mill" in the old Homestead Works, once the largest steelmak-

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BENNETT HARRISON, a professor in MIT's Department of Urban Studies and Planning, is currently a visiting professor at Carnegie-Mellon University in Pittsburgh. His most recent book, co-authored with Barry Bluestone, is The Great U-Turn, *published by Basic Books.*

ILLUSTRATION: JONATHAN SCHNEIDER

SAMUEL C. FLORMAN

Beyond Whistleblowing

I have followed with fascination and dismay the saga of Roger Boisjoly, currently the most renowned whistleblower in the land. Boisjoly was the chief engineer at Morton Thiokol, Inc., who before the *Challenger* disaster repeatedly warned his superiors about inadequacies in the joints of the shuttle booster. The night before the ill-fated launch, Boisjoly led a group of Thiokol engineers who argued urgently but vainly against proceeding. After the shuttle disaster, he was candid and outspoken at government hearings, revealing all that had happened before the launch and during the crucial decision-making process.

In response, Boisjoly's bosses and many of his colleagues treated him as a pariah. Six months after the accident, no longer able to endure what he termed the "hostile" environment at Morton Thiokol, he left the company on extended sick leave. Eventually Boisjoly was diagnosed as having a post-traumatic stress disorder and underwent two years of psychotherapy.

More recently, Boisjoly has embarked on a series of lectures that he says have provided him with a "positive catharsis." In speeches at more than 50 universities and addresses before most of the major engineering societies, he condemns corporations that "make arbitrary and irresponsible decisions that kill people and ruin the lives and careers of their employees without accountability." He urges engineers to stress moral responsibility and professional ethics.

Boisjoly's personal misfortune—publicized by his many lectures and interviews—has lent force to the growing crusade on behalf of whistleblowers. Proponents of this movement urge stronger laws to protect employees who speak out, and call upon professional societies to lend them increased support. A recent *New York Times* op-ed piece even suggests that we honor prominent whistleblowers by putting their pictures on postage stamps.

Rather than rekindle my enthusiasm for the cause of whistleblowing, the Boisjoly tragedy has started me thinking in completely different terms. Although I support laws to protect those who speak out against their organizations, I am distressed by the anguish that invariably ensues. We may admire whistleblowers for their courage and praise them for making whistleblowing more acceptable in the community, but there is no escaping the fact that what they do usually entails an element of personal disloyalty. We may protect whistleblowers economically, and even give them awards, but nobody can protect them from the hostility of colleagues who feel betrayed. Enduring this hostility—which often means tacit blacklisting within their industry—becomes a form of professional martyrdom. Why do we not try harder to set up procedures that will eliminate—or at least greatly reduce—the need for such martyrdom?

Organizational changes can eliminate the need for corporate martyrdom.

"Restructuring" the Organization

NASA has made strides in this direction since the *Challenger* disaster. "Restructuring" is the watchword, and actions have followed hard upon proclaimed intentions. The agency has created a new post: associate administrator for safety, reliability, maintainability and quality assurance. The holder reports directly to NASA's administrator and has the authority to stop shuttle launchings. NASA has also increased its safety and quality staff by more than a third and has trained staff members to be more aggressive in ferreting out problems and more vocal in demanding that they be corrected.

The agency also does more of its own analyses of part failures, supplementing those done by contractors. These studies pay particular attention to trends in defects reported immediately after shuttle flights. The lack of such mandatory trend analysis was one reason that Boisjoly's information about the weakness of the rocket joints in cold weather was not widely communicated. Other organizational changes are intended to eliminate rivalries between the Marshall and Johnson space centers. These rivalries contributed to lack of communication on crucial issues, including the rocket joint problems, on earlier flights.

The improvements that can be achieved through organizational change should not be underestimated. In the old days, collapsing buildings and other serious accidents in New York City were usually blamed on careless or unscrupulous builders and inspectors. After decades of bitter experience and fruitless demands for caution and honesty, a new system was put into place. Today, before a contractor can obtain a certificate of occupancy for a new building, independent licensed engineers must certify the integrity of concrete (both as mixed in the plant and as poured in the field), all welds and other connections, sprinklers, and about two dozen other safety considerations. This process is bothersome, costly, and time-consuming, but it works.

Many corporations have also restructured their safety operations, motivated by new laws and regulations and by judges and juries who are assessing liability even in the absence of proven negligence. Companies can be penalized for failing to keep proper records of product sales and distribution, of project failures, and of customer complaints. They are modifying their business practices accordingly. Such operational changes protect the community better than an army of whistleblowers. "The one choice engineers, designers, and their employers no longer have is whether or not to pursue safety goals," write John Kolb and Steven S. Ross in *Product Safety and Liability.*

In *Fortune,* an article entitled "Listen to Your Whistleblower" advises managers to start an ombudsman system or at least to cultivate an extensive personal "grapevine"

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SAMUEL C. FLORMAN, a civil engineer, is the author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, Blaming Technology, *and* The Civilized Engineer.

ILLUSTRATION: BRUCE MADDOCKS

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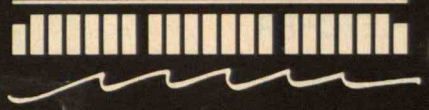

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BY DOROTHY C. WERTZ AND JOHN C. FLETCHER

Disclosing Genetic Information: Who Should Know?

ONE of the many difficult aspects of HIV infection—the precursor to AIDS—is the moral problem that arises when patients do not want to let sexual partners know about their condition. Their doctors face a grave dilemma in choosing between two medical duties: preserving patients' privacy and warning innocent third parties of impending harm.

This ethical problem is hardly unique to HIV infection. Disclosure of medical information that some patients prefer to keep confidential will become a major concern in the next 15 years. Researchers are on the verge of learning a wealth of new details about human genes. New tests for genetic disorders and susceptibilities to common illnesses such as cancer and heart disease will lead relatives, spouses, insurance companies, and employers to claim a stake in the resulting information.

We believe that people with hereditary diseases have a responsibility to warn their relatives about genetic risks. But if patients are unable or unwilling to accept this responsibility, the task of informing family members should fall to their doctors. It is time to change the legally recognized "standard of care" that discourages doctors from doing so. Of course, the line must be carefully drawn to protect the patients' interests. Still, the interests of other parties at high risk should outweigh privacy for its own sake.

Sometimes the Hippocratic ideal of confidentiality between doctor and patient should be breached.

Breaking the Rules

Why would patients not discuss a genetic disease with relatives—or with spouses, since the disorder could be passed on to children? In some cases, they might feel ashamed, or fear that their employers would fire them if they found out. In other cases, refusing to inform is a symptom of the illness. Consider Huntington's disease (HD), an untreatable condition that strikes in middle age and produces mental and motor deterioration before ending in death. HD is a Mendelian dominant disorder, which means that a patient's children have an even chance of developing it. In its early stages, HD can cause personality changes, especially increased secretiveness. A patient affected this way may not be willing to help family members determine whether they and their fetuses also carry the HD gene. Recombinant-DNA testing for the gene requires that blood samples from relatives be compared with one from the patient.

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ILLUSTRATION: MARCEL DUROCHER

The dilemma comes when doctors consider breaking the code of silence about such a patient's condition. As a result of the disclosure, the family might put unwelcome pressure on the individual to provide a blood sample. Moreover, the doctor would be contravening a principle that dates back to Hippocrates and appears in Western physicians' codes of ethics.

Despite its deep roots, however, privacy in doctor-patient relationships is not an absolute. It is not recognized in about a third of the United States. And all states require doctors to inform public health officials whenever patients have any of a number of communicable diseases.

The courts, as well, are giving rise to an ethic of disclosure in certain cases. A landmark case concerning confidentiality is the 1976 *Tarasoff v. Regents of University of California* lawsuit. A university psychiatrist had failed to inform a woman that his patient had threatened to kill her. When the patient murdered her, the woman's parents sued. The court ruled that the doctor had a legal obligation to warn the woman. The judge said that members of our "interdependent" society should not be exposed to risks that simple communication could eliminate.

The ethical stance on disclosure is loosening up outside the legal realm as well. In 1983 a presidential commission studying ethical problems in medicine recommended that doctors warn patients' relatives as long as four conditions apply: the risk of harm would be great, the harm would be serious, the information would be used to prevent or minimize harm, and only information directly related to the disorder would be revealed.

Even many doctors lean toward disclosure. In a 19-nation survey conducted in 1985-86, we asked more than 1,000 medical geneticists whether they would uphold the privacy of patients with HD or parents of children with hemophilia. Only a third of almost 700 respondents said they would. Another third said they would tell patients' relatives if they asked, and a quarter said they would seek out relatives even if they did not. The remaining 10 percent would refer the matter back to the family physician.

Although the trend toward informing relatives and spouses is healthy, patients need safeguards to ensure that genetic information is not divulged outside this circle. Granted, no responsible doctor would give test results to an employer or insurer without the patient's consent. But it is relatively easy for companies to coerce consent from people by otherwise denying insurance or employment—putting affected individuals into a Catch-22. That practice should be outlawed.

After all, harsh practices concerning genetic risks have haunted us in the past. Reluctant to pay for birth defects, most insurance companies denied coverage to all newborns until the late 1960s, when the American Academy of Pediatrics successfully campaigned for state laws requiring coverage. And some employers used to screen job applicants to see if they were carriers of the sickle-cell gene, even though carriers cannot develop the disease. While the practice lacked scientific foundation, the employers argued that carriers were more susceptible to workplace hazards. Screening stopped in 1981 after public controversy erupted over a claim by the Air Force Academy that carriers might develop acute illnesses associated with sickle-cell disease if they were in airplanes that depressurized.

Expanding Disability-Rights Laws

If government does not pass laws denying employers and insurers access to the results of genetic tests, then at the least it should protect individuals who could be harmed. In the event that states allow insurers to gather genetic-test information as they do other medical data today, publicly funded insurance pools should be established to cover people at risk for developing genetic disorders. And employers shouldn't be able to fire or refuse to hire individuals just because they're genetically at risk. Federal and state governments should include genetic predispositions under disability-rights legislation.

The one reasonable exception to rules covering employers would be when an active disorder compromises public safety. Suppose a bus driver were suffering from the early stages of Huntington's disease, at which time hand-eye coordination and judgment of speed can be impaired. In such a case, the employee should be eligible for long-term disability insurance, in accordance with the employer's benefits package.

Just as genetic records should be shielded from employers and insurers, so should they be shielded from government agencies. Lawmakers might be tempted to require doctors to breach confidentiality in the case of certain genetic disorders and inform public health departments—which would then have to contact all family members. That would be unwise. Of course, anonymous reporting would be beneficial; it would improve U.S. statistics on the frequencies of genetic disorders. But if names were attached to medical records, the government would probably end up keeping track of family transmission of genetic disorders. Not only would such state interference be unwieldy, but it could easily lead to access by employers and insurers, or even to eugenics laws.

Protecting the interests of affected individuals and their families should be a matter of professional standards. Physicians need to agree on when confidentiality can be overridden, based on the magnitude of risk. They should follow the guidelines for disclosure developed by the president's commission.

Before they can do that, however, doctors must decide how great the genetic risk needs to be before they inform relatives. A study done 10 years ago by J. R. Sorenson, a University of North Carolina medical sociologist, found that most geneticists regarded a 21 to 50 percent chance of developing a disease as high. Most patients, however, interpreted the same risks as moderate. Informal research suggests that these numbers have dropped in the past decade, with many geneticists now regarding risks of more than 5 or 10 percent as high. Since the public may disagree with geneticists somewhat, doctors should be sensitive to the opinions of patients as well as colleagues when developing standards for overriding confidentiality.

Finally, doctors should carefully limit the details they disclose to what directly concerns serious genetic disorders. If a genetic test incidentally reveals false paternity, only the mother should be told. Her husband can simply be informed that the disorder won't recur in children that the couple may have in the future.

Unless physicians develop clear guidelines about breaches of confidentiality, patients will not trust doctors enough to seek screening. It's not only critical for individuals to learn genetic facts about themselves. It's vital to recognize that hereditary information is a family possession rather than simply a personal one. ■

BY JOHN F. AHEARNE

Fixing the Nation's Nuclear-Weapons Plants

Three new groups will monitor the troubled U.S. defense reactors, but long-term problems remain.

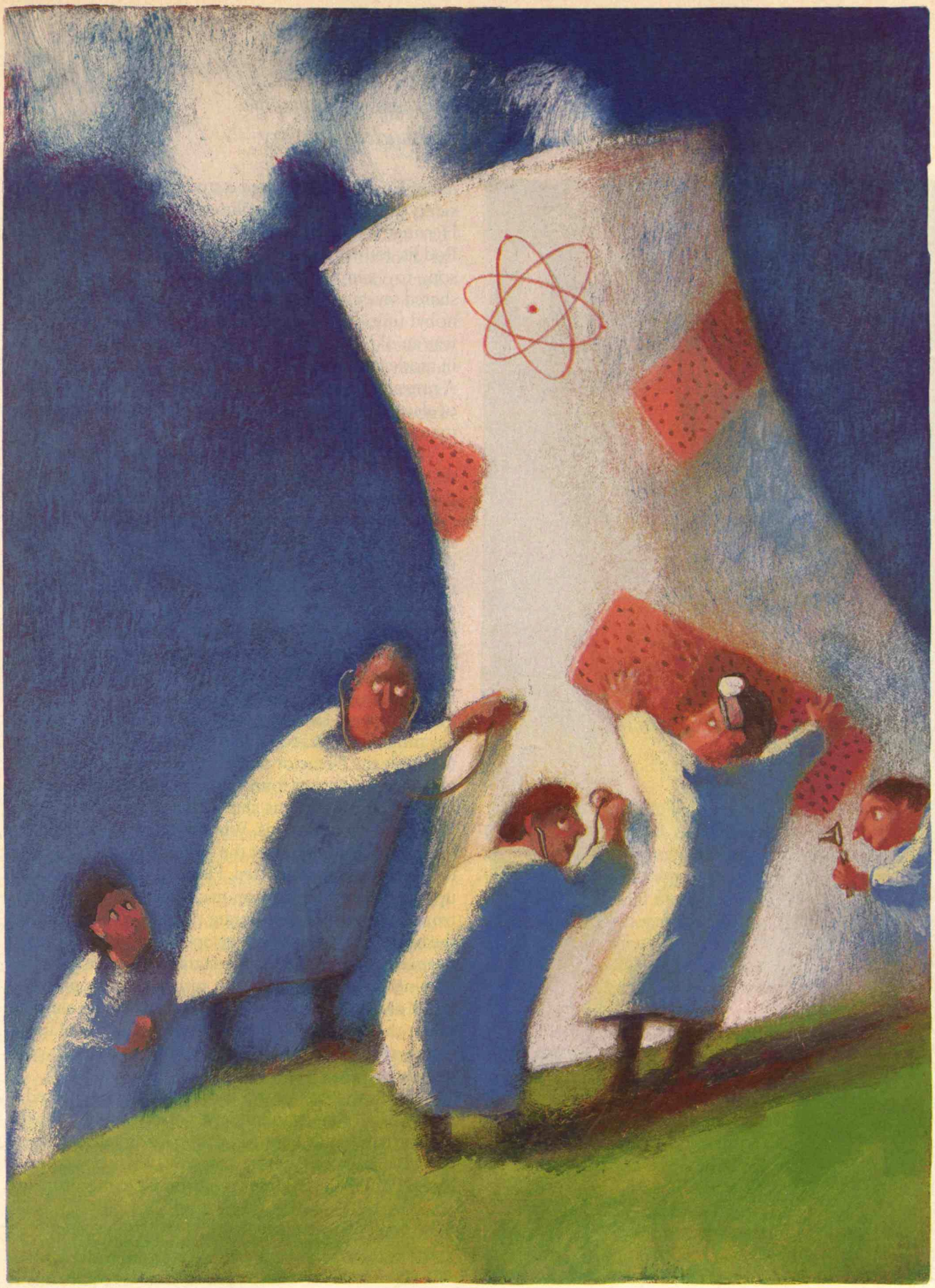
On January 1, 1988, the Department of Energy (DOE), which runs the nation's nuclear-weapons production program, had four reactors operating or set to resume operation after repair. By the end of last year the N-reactor at Hanford, Wash., which makes plutonium, had been closed, probably permanently. The three reactors at Savannah River, S.C., which produce both plutonium and tritium, had also been shut down because of operating and repair problems.

Efforts to restart these units have stalled as evidence of inadequate safety standards throughout the defense nuclear complex continues to unfold. These developments, spanning 30 years of classified operations, reveal that standards in DOE operations have not kept pace with changes in the commercial nuclear industry. Congress and DOE have responded by setting up three groups to oversee the department's attempts to improve, and President Bush has chosen a veteran of the nuclear navy, former chief of naval operations Adm. James Watkins, to pull the department back together.

Appointing Watkins and creating the oversight groups are major steps. However, recognition is growing that some problems will take decades—as well as significant new funding—to fix. Building a new tritium reactor, for example, will require 10 years *after* money is approved. Thus Congress and the energy secretary may have to decide whether the need for tritium—a key ingredient in nuclear weapons that has a half-life of only 12 years—must take precedence over efforts to bring reactors closer to commercial standards. And Congress may have to make more profound institutional changes, such as giving the Nuclear Regulatory Commission (NRC) authority to regulate defense reactors and transferring the nuclear-weapons budget to the Defense Department.

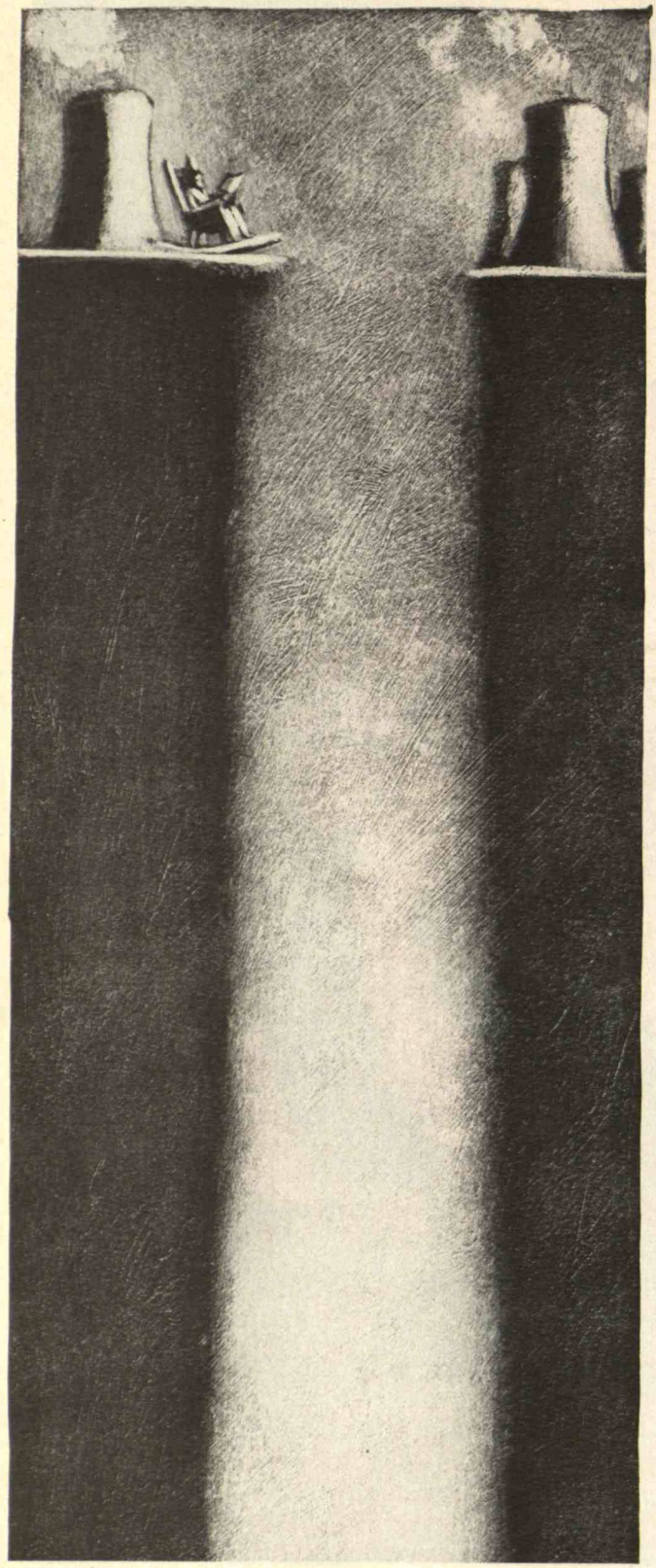
Congressional efforts to uncover problems with the DOE weapons complex began in the late 1970s, when Sen. John Glenn (D-Ohio) received complaints about work-safety practices at uranium-enrichment plants in his state. His initial reaction was that the department was running a good operation, but he sent DOE a query for information as a constituent service nevertheless. Poor responses led Glenn to ask the General Accounting Office to investigate, and this request opened a Pandora's box. The agency confirmed some of the allegations in the first of more than 25 GAO reports that laid the path along which numerous other groups would follow.

Shortly after the Chernobyl accident in April 1986, the National Academy of Sciences and National Acade-



ILLUSTRATIONS: KEVIN HAWKES

The mishaps with the P-reactor showed how far practices in the defense program diverge from those in the commercial nuclear industry.



my of Engineering formed a study group to review the safety of DOE nuclear facilities. Energy Secretary John Herrington also asked a panel of six experts, led by Louis Roddis, former president of Chicago's Consolidated Edison, to examine Hanford's N-reactor. That reactor shared several important features with the ill-fated Chernobyl unit: it was designed for defense production, it was an old design without several safety systems found in modern reactors, and it had a massive graphite core. A pressurized-water reactor, it generated 860 megawatts of electricity for commercial use while making weapons material during full operation.

The Energy Department was surprised at the Roddis panel's report: all six members criticized DOE practices, and two recommended shutting down the reactor.

By the time the academy committee published its report at the end of 1987, DOE had decided to shut down the N-reactor for six months while spending $50 million to upgrade it. Secretary Herrington cited the many operating problems, as well as the fact that the country is "awash in plutonium." Finally, in the spring of 1988, the department announced it was putting the reactor in "cold shutdown," which has the characteristics of permanent closing.

Then events last August spurred closer looks at the Savannah River reactors. In the spring a brace designed to enable the P-reactor to withstand the shaking of a severe earthquake was found to have been installed incorrectly. The reactor was shut down for several months for seismic modifications. When operators began removing control rods to restart the unit in August, the power did not increase as expected. Helium-3, which had built up in the core from tritium decay, was absorbing neutrons that normally penetrate the fuel rods and cause the fission chain reaction. The operators and the control-room engineer couldn't understand why the reactor was not increasing in power. But rather than stopping to figure out what was going on, or—even better—shutting down the reactor to figure out why their calculations were wrong, the employees continued to pull out control rods.

Withdrawing at least 5 more rods than expected is not unusual for Savannah River reactors (actually, the units are in "equivalent rods," but "rods" are sufficient for this discussion). The reactors are old (they were built in the 1950s), the equipment is difficult to monitor, and

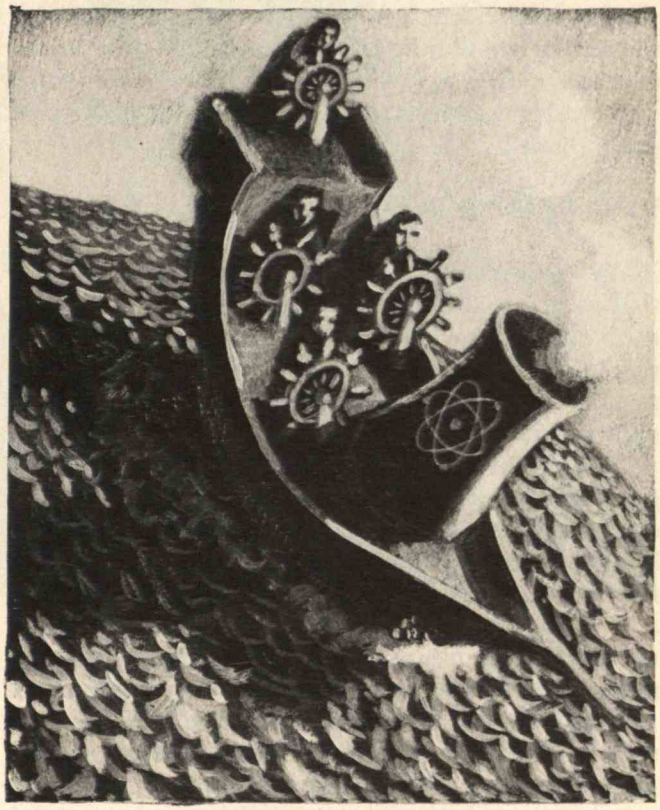
JOHN F. AHEARNE, until recently vice-president of Resources for the Future, chairs the Department of Energy's Advisory Committee on Nuclear Facility Safety. He was head of the Nuclear Regulatory Commission from 1979-81 and served as a deputy assistant secretary of defense from 1972-77.

A newly aggressive safety office has transformed the world in which DOE staff and contractors live.

the rods tend to stick. However, the reactor-operations manager at Savannah River remembered only one situation in 30 years of operations when technicians had to pull as many as 20 rods above their calculations. In this case they pulled out 60 more rods than expected. Eventually, even this amount was not enough to maintain power, and the staff shut down the reactor.

In the next few days, several other events occurred that led the Energy Department to conclude that the P-reactor should not run until what had happened was understood and changes were made to improve practices. Although the events posed no threat to the reactor or the public, they are not compatible with safe operation.

The August events provoked numerous reviews of Savannah River. Each has uncovered more problems, including a list of events that occurred over many years labeled the "dirty 30" by a DOE official. These include two instances where fuel rods melted when removed from the reactor into an uncooled environment. Inspectors have also found substantial cracking in pipes at several Savannah River reactors. The units have not operated since August 1987 because of these numerous problems, which have led to further investigations, calls for more operator training, and growing recognition that significant time and money would be needed before restarting the plants.



Isolation Breeds Complacency

The mishaps with the P-reactor showed just how far practices in the defense reactor program have diverged from those in the commercial nuclear industry. The accident at Three Mile Island taught utilities that the unexpected could occur and led to major improvements in operating practices and training, instrumentation, accident analysis, and maintenance. But the veil of secrecy surrounding the weapons program prevented these changes from becoming part of the DOE knowledge base.

For example, Louis Roddis was surprised to find that the post-TMI emphasis on preventing a hydrogen explosion had not led Hanford engineers to incorporate this phenomenon into their analyses. Dennis Wilkinson, another member of the N-reactor review panel and the first president of the Institute of Nuclear Power Operations, a group set up to improve nuclear industry performance following TMI, wrote, "There is an apparent sense of complacency at many levels from the DOE staff on down through contractor operations personnel that 'It can't happen here' at the N-reactor. The major lesson from TMI-2 and Chernobyl-4 is that accidents can happen."

This isolation was illustrated last year, when a well-known nuclear-safety expert met with nuclear-safety staff of a DOE contractor. The expert wondered why he did not recognize any of the employees from national and international meetings. The staff members told him that they did not attend those meetings because they could learn nothing from them. The employees seemed unaware that a gap had grown between their practices and those of their colleagues in the commercial nuclear industry.

The gap means that safety analyses like those the Nuclear Regulatory Commission requires for commercial reactors have been done poorly or are out of date. For example, utilities must analyze a "design-basis accident"—the worst situation in which operators are able to shut down a plant without exposing the public to significant amounts of radiation. The design-basis accident for the Savannah River reactors is a "double-ended guillotine break"—the breaking of both ends of a large cooling pipe. Richard Meserve, chairman of the national academy's panel, informed Secretary Herrington six months before the panel's report was due that the anal-

No criteria exist for determining how safe is safe enough when national security is at stake.

ysis for this accident was inadequate to support running the reactor at full power. DOE responded by reducing operating power to less than 50 percent; further study has revealed that the analysis does not justify even these power levels.

Lack of Funding and Oversight

Many problems with defense reactors stem from the fact that no strong advocate pushed for funds to modernize them during 30 years of operation. For example, a 1982 report commissioned by Secretary Herrington recommended building a new reactor, primarily to produce tritium, but it never received funding.

Compounding this problem has been the fact that no group has monitored DOE practices, either within the department or outside it. DOE and its predecessors, the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), have all lacked a critical review group reporting to the top of the organization, even though most industries recognize the importance of such a "devil's advocate." And no independent group has overseen DOE operations, as the NRC oversees commercial reactors. This situation has recently changed, but, ironically, there may now be too many cooks stirring the pot.

In 1985 Secretary Herrington formed an internal Environment, Safety, and Health office, which he significantly strengthened in 1987 in response to criticism by the national academy. Herrington also hired Richard Starostecki, a long-time NRC employee, who brought an aggressive, adversarial attitude, along with several former NRC people, into the department. His findings have helped force public discussion of the issues that lay behind the cloak of secrecy, and have brought Congress and the press into the game. This approach has transformed the world in which DOE staff and its contractors live. The office also wrote a draft department safety policy and has stationed inspectors at the main facilities.

In 1988 DOE created the Advisory Committee on Nuclear Facility Safety, which I chair, again on the recommendation of the National Academy of Sciences. This committee is similar to the NRC's Advisory Committee on Reactor Safeguards in that members, all experts in various fields, devote only a fraction of their time to advising DOE. Last December the group raised many questions about DOE's approach to improving the safety and restarting the reactors at Savannah River.

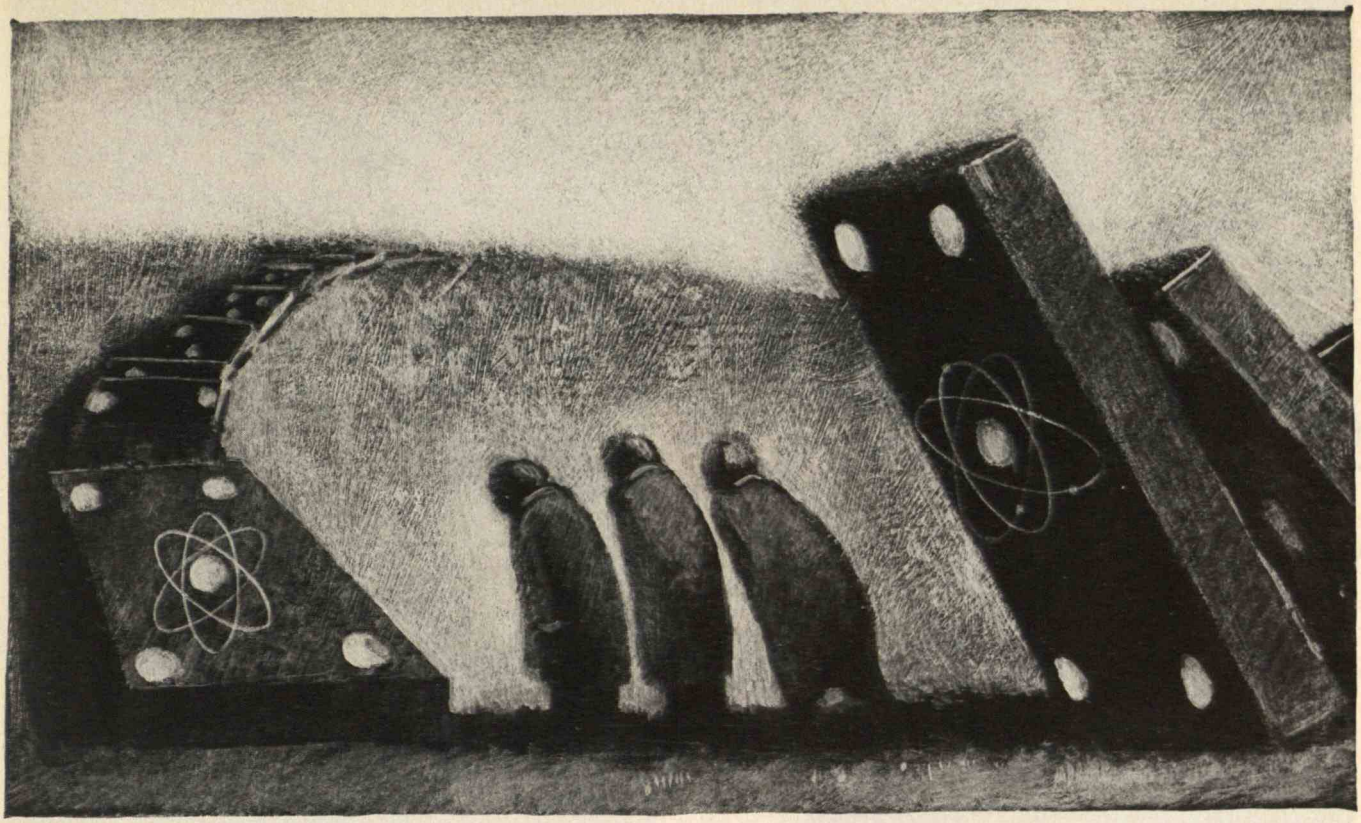
A larger, full-time oversight body—the Defense Nuclear Facility Safety Board—is also joining the fray. This board owes its life to Sen. John Glenn, who in the mid-1980s proposed setting up an independent agency to oversee DOE facilities after continued frustration with the department. Congress finally agreed last year to fund the agency, which will function as a mini-NRC, with five members appointed by the president and confirmed by the Senate. The new board will have 100 full-time staff, station inspectors at DOE plants, and review all standards for running them. It cannot require the energy secretary to take action, as the NRC can for commercial operators, even though Sen. Glenn fought for such a provision. Still, the board can conduct investigations, subpoena witnesses, and make recommendations. The energy secretary must notify the president, the Senate Armed Services and Appropriations committees, and the Speaker of the House within 45 days if he or she decides to reject any of these recommendations.

The new mini-NRC, to demonstrate that its sponsors were correct in establishing it, will likely move quickly to write a safety policy for the Energy Department, review internal regulations, and station inspectors. The problem is that the Environmental, Safety, and Health office is performing the same valuable mission. The two may conflict in their attempts to monitor daily operations and details of all procedures. Congress may have to step in and decide which functions each agency should perform.

Finding Money and Good People

Not only effective oversight but billions of dollars will be needed to resolve the problems with the military nuclear complex. Efforts to restart the reactors, and build new ones, will compete with moves to clean up contamination around DOE plants. The General Accounting Office projects that all these efforts will require $150 billion. The bomb-making program already dwarfs other DOE activities, accounting for $7.9 billion of the department's $11.2 billion budget in fiscal-year 1988. Budgeting the $150 billion that the GAO projects would require nearly a 50 percent increase in DOE funding even if spread over 30 years.

Such sums are not unusual for Defense, whose 1988 budget was $282 billion. Assigning these operations to the Defense Department would make sense, since funding and management would come from the department the facilities actually serve. If this were done, transferring oversight to the NRC would be a logical step. That agency could then take responsibility for enforcing safety standards at all the nation's nuclear plants.



Finding competent people to solve the extraordinarily complex problems of DOE plants may prove more difficult. These enormous problems would challenge the most competent technical managers. DOE operations, like other complex federal programs, are burdened with chronic inefficiency and competing political demands, and embedded in a swamp of public criticism. Low pay scales compound the difficulties. Thus even qualified managers are not stepping up to do the job. This may continue to be a problem even if the energy secretary issues a call for "public service."

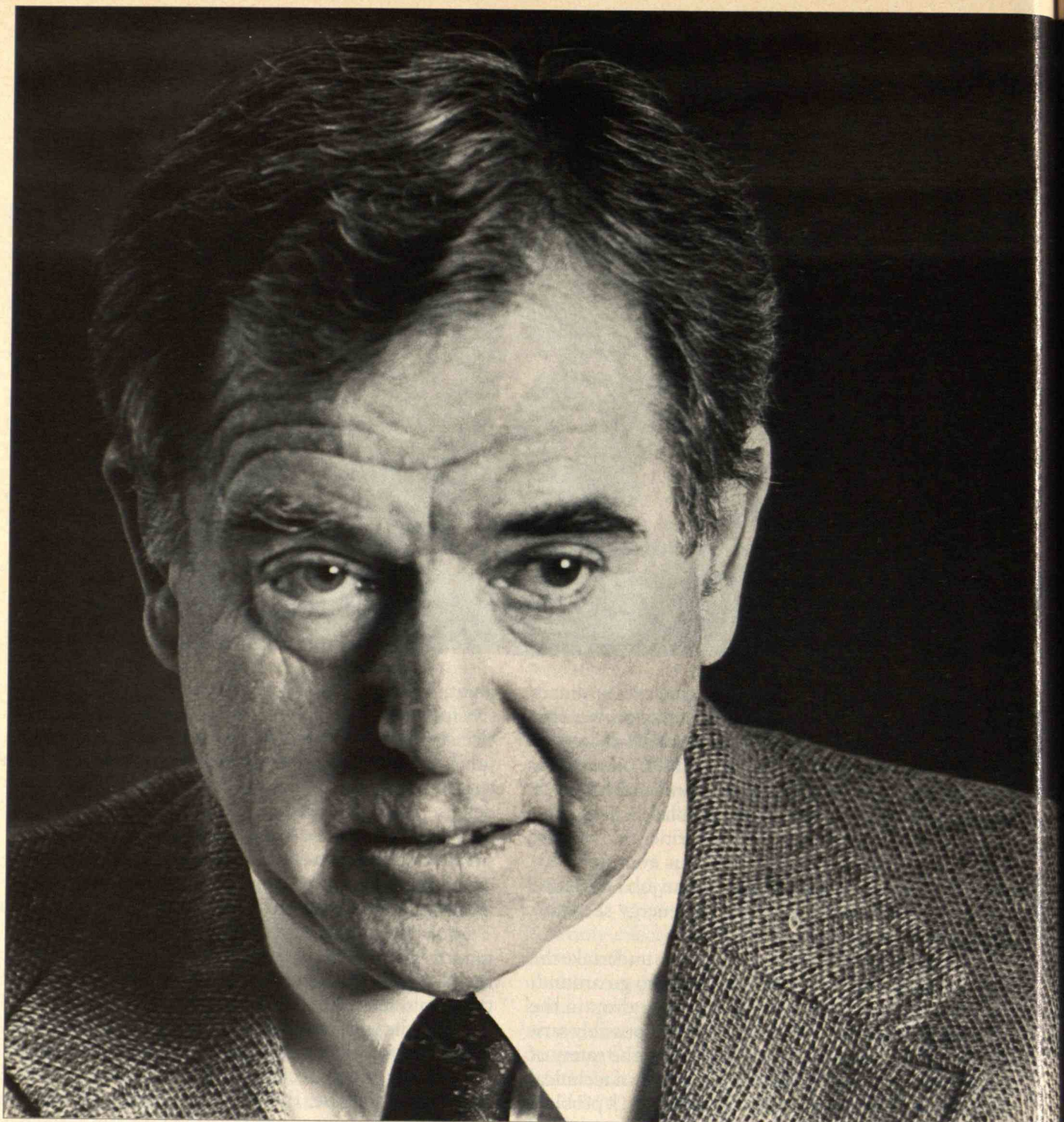
Even if competent people are willing to undertake the task, there may not be enough expertise to go around. The civilian nuclear industry points to a drop in the ranks of nuclear-engineering students as a possibly serious barrier to maintaining and improving the safety of utility reactors. Another barrier is the lack of technical training and competence in the United States, a problem that begins in elementary school. That situation, decried by the national academies and many other groups, cannot be solved in a month, a year, or even a decade. Fixing the defense complex would be much easier, and perhaps doable, if such concerns had been resolved sooner.

Given the host of problems, can the reactors be restarted? The issue is complex because no criteria exist for determining how safe is safe enough when national security is at stake. Years of AEC and NRC regulations have defined guidelines for protecting public health while operating commercial reactors. Closing a utility power plant, if necessary, can prove inconvenient and expensive for its owners and the public, but other sources of electricity can be found. But no one, including the national academy panel, has determined whether a different definition of "adequate safety" should apply to defense reactors. Making such a determination may prove necessary since these old units cannot attain the standards of modern commercial plants—although they can come close. (Old commercial plants do not reach the standards of modern units, either.)

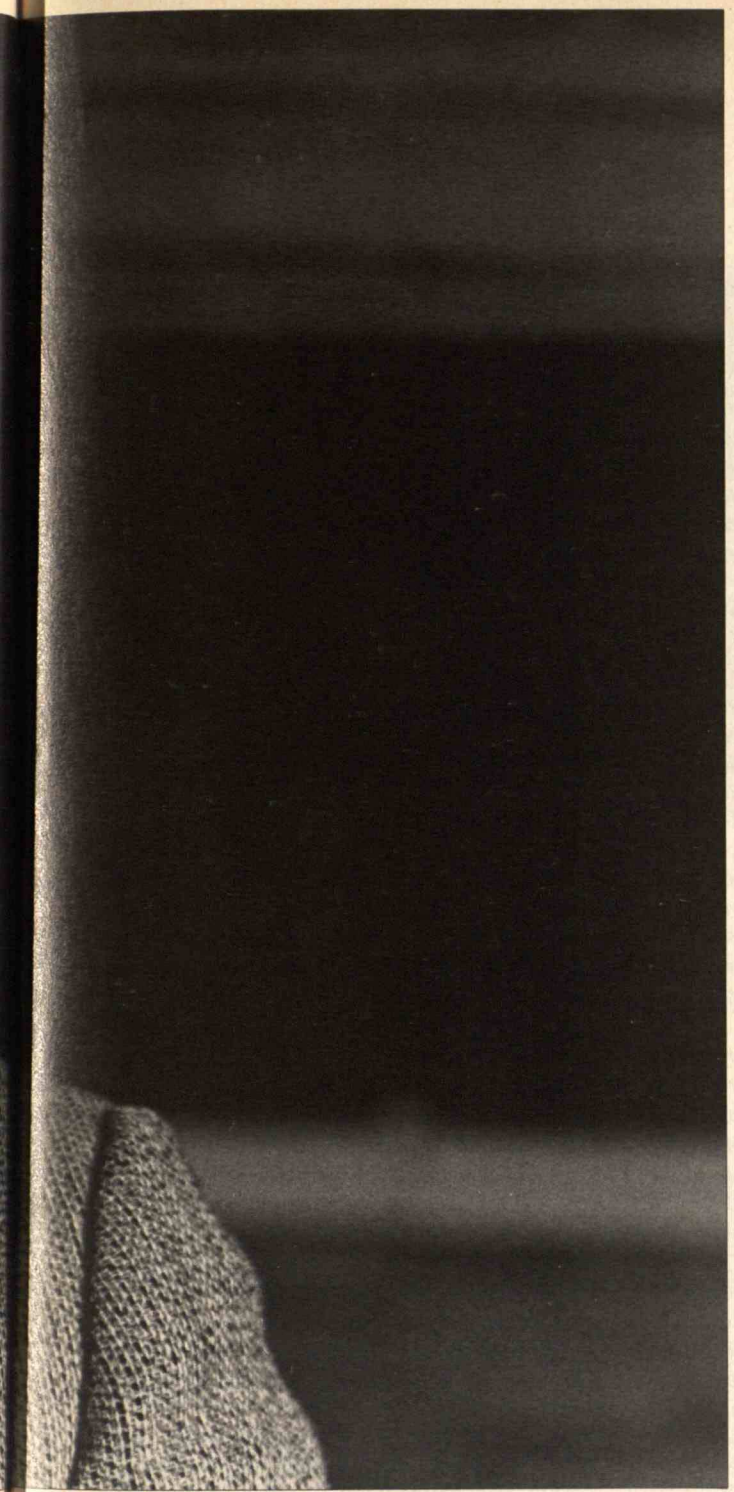
Louis Roddis expressed the problem in his 1987 report: "I recommend that the department shut down the N-reactor unless a positive judgment is made that the requirements for defense material warrants accepting public hazards exceeding those of commercial reactors."

Decaying tritium will prove to be the sticking point. I expect the energy secretary, after consulting with the secretary of defense, the White House, and key members of Congress, to weigh the need for tritium against progress in upgrading defense reactors. A U.S.-Soviet agreement to cut back strategic nuclear arms could affect this decision—if, unlike the INF Treaty, it included a mechanism to destroy warheads and not just delivery vehicles.

No matter what happens, restoring public and congressional confidence in DOE and its contractors will be essential before the defense reactors can operate. Now that better regulatory mechanisms are in place, the process of upgrading the units can move forward. But no one expects it to be easy. ■



AN INTERVIEW WITH ARNOLD



CONFRONTING THE CRISIS IN HEALTH CARE

RELMAN

Last year, the United States spent $550 billion on health care—about 11 percent of GNP and more than any other country in the world. If current trends continue, health-care costs will double by 1995 and triple by the turn of the century to $1.5 trillion, or 15 percent of GNP. And by the year 2005, the federal budget for Medicare alone will exceed that for either Social Security or the Department of Defense. Despite such massive investments, some 35 million Americans, a third of them children, remain uninsured.

Recent studies have revealed a new worry: wide differences in treatment from region to region, city to city, and even among hospitals within the same city. The National Leadership Commission on Health Care, a panel of private citizens and health professionals, has recently argued that such variations reflect serious problems in the quality and appropriateness of much of the medical care people receive.

The scope and complexity of these problems has inspired a new round of proposals for reform. Some recommend incremental changes to the current system. For instance, Stanford University professor Alain Enthoven's "consumer-choice plan for the 1990s" would maintain the current network of private and public insurance. At the same time, it calls for creating a "public sponsor" in each state to finance health insurance for those who lack it and to buy a standard package

PHOTOS: STU ROSNER

"The real engine behind the rise in health-care costs is technology."

of care from competing health maintenance organizations (HMOs).

Other proposals call for more comprehensive changes. The group Physicians for a National Health Program has outlined a plan for a system similar to that of Canada. Funded by the federal government but administered by states and communities, the system would replace the current multiplicity of private health insurance programs with a single, public payer and cover the entire population.

Still other plans address questions not only of cost and access but also of quality. For example, the National Leadership Commission has recommended a "national quality improvement initiative" that would set up a system to evalute medical technologies and assess the effectiveness of current medical practices.

Since his appointment as editor of the New England Journal of Medicine *in 1977, Arnold Relman has been an outspoken critic of many aspects of the U.S. health-care system and a persuasive advocate of reform. During his tenure, the* Journal *has become a forum for many of the proposals to reorganize health care and the practice of medicine.*

Dr. Relman received his medical degree from Columbia University in 1946. During his 40-year career, he has served as a physician, researcher, and professor at a number of prominent institutions, including the Yale–New Haven and Boston City hospitals and the medical schools of Boston University, the University of Pennsylvania, and Harvard.

Recently, Technology Review *editors Sandra Hackman and Robert Howard talked with Dr. Relman about the present and the future of U.S. health care. He discussed the role of new technologies in the crisis, the need for physicians to alter the way they practice medicine, and the changes that are likely to occur in the years ahead.*

TR: What are the main elements of the crisis in the U.S. health-care system?

RELMAN: There are three related problems. First, health care is too costly. The cost is rising at a rate that is clearly disastrous. It simply cannot be sustained. And the people who have to pay—primarily government and the large employers—are saying they can't afford it. They cannot survive a continued increase at the present rate.

Second, our system is inequitable. We are not able to take care of a very large fraction of our people. Somewhere between 35 and 40 million Americans are inadequately covered and are getting inadequate care—and sometimes no care at all.

Third, the care we do provide is inefficient and of uncertain value. Even though we're spending more than any other country in the world on health care, there is a growing sense that we're not getting value for our money. We may be wasting a lot of money on procedures that are unnecessary or ineffective. The sad thing is, we don't have adequate machinery for deciding what's worthwhile and what isn't.

TR: The '80s are supposed to have been the decade of "cost containment." Why hasn't cost containment worked?

RELMAN: It hasn't worked because it's based on a misunderstanding of the nature of the health-care system. The assumption has been that competition would control costs. It's an absurd supposition because there is no real competition in medicine. Medicine is not a market like other markets.

First of all, the payers—businesses and government—are not those receiving the individual services. They are simply buying insurance. The only thing they can negotiate on is the cost of the premium. But premiums have been going up steadily, both for HMOs and for more traditional health insurance plans.

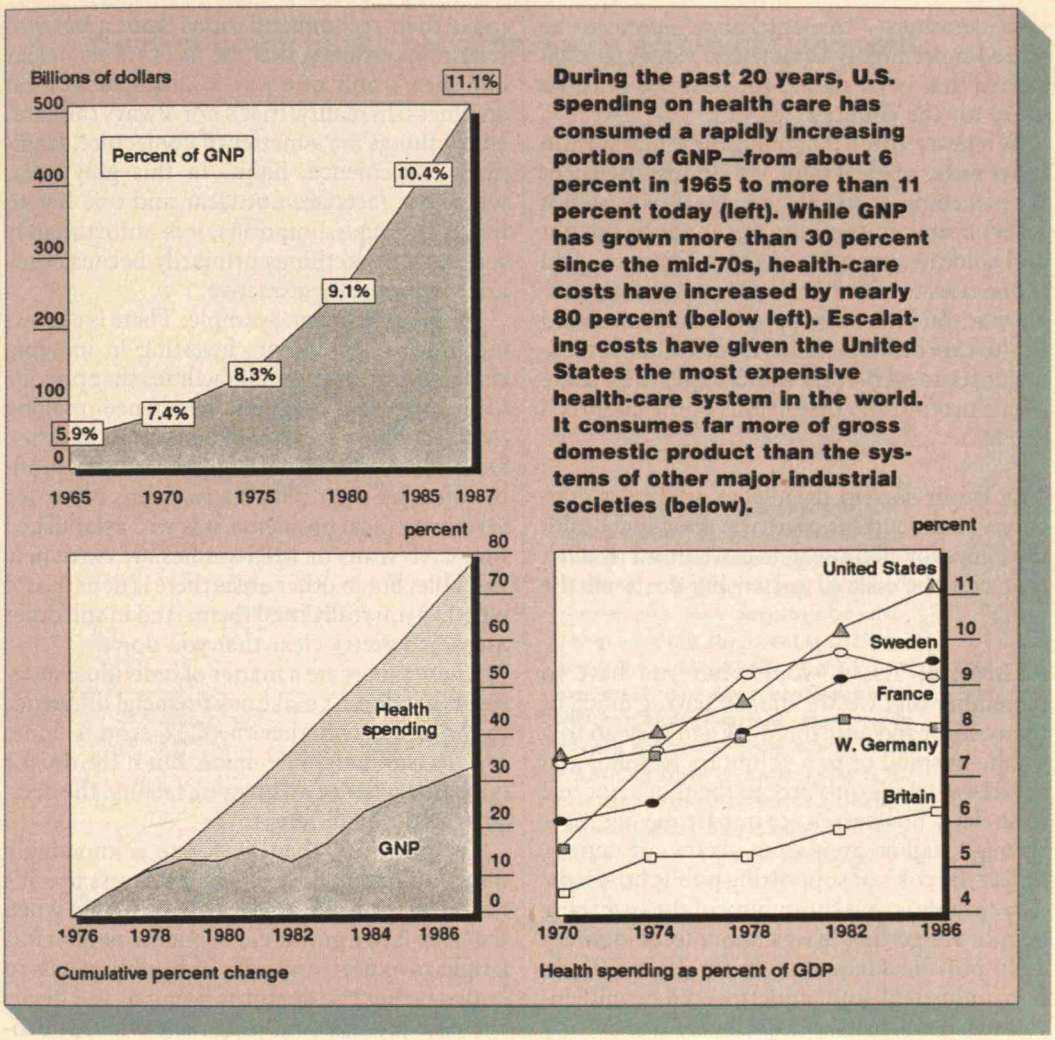
Also, there is no true price competition for procedures. The only price competition—such as it is—has been among insurers and HMOs. There's been absolutely none in fee-for-service medicine.

Even if you want to treat medicine as a market, you wouldn't be controlling costs even if you could keep prices down. Markets exist to sell, to expand their sales. There is no mechanism in such a model for controlling the total volume of services.

So "competition" was a lot of talk. It fit in with the ideology of the Reagan administration, but it had no relationship to reality.

TR: Does that mean that even the growth in HMOs has not greatly affected costs?

RELMAN: What HMOs have done is reduce the use of the hospital. They've transferred a lot of



During the past 20 years, U.S. spending on health care has consumed a rapidly increasing portion of GNP—from about 6 percent in 1965 to more than 11 percent today (left). While GNP has grown more than 30 percent since the mid-70s, health-care costs have increased by nearly 80 percent (below left). Escalating costs have given the United States the most expensive health-care system in the world. It consumes far more of gross domestic product than the systems of other major industrial societies (below).

of care that used to to be done in the hospital to doctor's office, to the ambulatory care facility. That saves money, because hospital care is more expensive. But once that saving is achieved, costs go up at the same rate as before, because the forces that are driving costs up continue unabated.

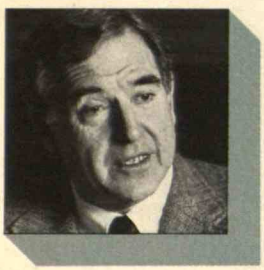
The real engine behind the rise in medical costs is technology: the increasing use of technology by a growing number of doctors who are all trained to provide high-tech, expensive services. That's what they do for a living.

Add to that the expectations and desires of patients. Patients expect everything possible to be done for them. They are reasonably well informed about the latest "medical miracles," and they want them. Doctors are only too glad to do everything they can, because it is what they have been trained to do, they want to help patients, it's profitable, and furthermore they're afraid of malpractice suits.

This is another way in which conceiving health care as a market is a mistake. Most patients don't have to reach into their wallets and pay for each service. It's already been paid for by their insurance. They're claimants, not customers. They feel that they're entitled to it, and there is no limit.

TR: If the market model is so inappropriate for health care, why has it been so popular?

RELMAN: There is a growing confusion about the role of the professions in American society—in particular, the role of the medical profession. We live in a time when economic



"Wherever you look in medicine, new machines or procedures are widely applied long before there is evidence whether they are any good."

considerations—"free enterprise"—seem to be prized more highly than social values. It's assumed that what's good for business must be good for the country.

Whatever virtue that philosophy may have in other walks of life, I think it's seriously deficient when it comes to health care. Health care is not an economic commodity. It cannot be bought and sold the way other commodities are. And if one tries to make it a commodity, the result is what you have now: people who can't afford health care being excluded from the market, rising costs as everybody wants to get their share of the profits, and distortions of the country's needs.

TR: If our society decides to address the inequity of the current system by providing health insurance for all those who can't afford it, won't that run the risk of increasing costs all the more?

RELMAN: Yes, it would, but you have to remember that we are already paying much of the cost for the uninsured. When they go to a public hospital or to a voluntary hospital and get free care, it's only free to them; it's not free to society. Businesses are in part paying for it through higher premiums. Taxes, of course, reflect the costs of supporting public hospitals. The trouble is that the quality of the care these people are getting leaves much to be desired.

To provide adequate care for 35 or 40 million uninsured and underinsured would increase overall costs, but probably not by very much. And if we eliminated the waste and the unnecessary overhead we're paying now, I don't think we'd feel the added responsibility at all.

It's hard to estimate this, but knowledgeable people think that a minimum of 7 or 8 percent and maybe as much as 15 percent of the cost of health care in this country is due to overhead and to the profits of the hangers-on—the multiple insurers, the consultants, the management, the costs of billing and collecting and identifying services, the profits of the private insurance companies, and so on.

Unnecessary Medicine

TR: How does the current system affect the quality of care?

RELMAN: Many people think that doctors make their recommendations from a basis of scientific certainty, that the facts are very clear and there's only one way to diagnose or treat an illness. In reality, that's not always the case. Many things are a matter of conjecture, tradition, convenience, habit. In this gray area, where the facts are not clear and one has to make certain assumptions, it is unfortunately very easy to do things primarily because they are economically attractive.

Let me give you an example. There is a growing practice of doctors investing in imaging centers—out-of-hospital facilities that provide CAT scans and magnetic resonance imaging (MRI) and nuclear tests of one sort or another. Doctors, as part owners of these facilities, profit by referring their patients to them. Now, for certain medical problems, it is well established that CAT scans or MRI studies are extremely valuable, but in other areas there is debate over whether you really need them. And in still other areas, it's pretty clear that you don't.

These things are a matter of individual judgment. If it doesn't make any financial difference to the doctor whether the CAT scan is done, one decision might be made. But if the doctor is a part-owner of an imaging facility, the decision might be different.

I'm not saying that the doctor is knowingly doing something wrong or unnecessary. It's simply that his judgment might be biased when the issue is in a gray area. What the patient has a right to expect, and what the public needs to know, is that the doctor is going to use his or her best professional judgment without economic bias.

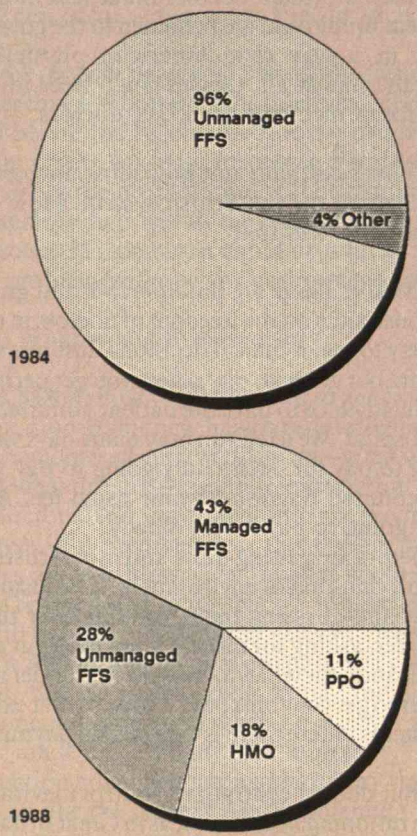
TR: So you would prohibit doctors from investing in such centers?

RELMAN: Oh yes, I think it should be made illegal. It's basically a form of kickback. And I believe that by logical extension of accepted medical standards it is unethical. I'm dismayed that organized medicine has been slow to draw that conclusion.

TR: You mentioned earlier that technology is pushing costs upward. Isn't that the price we pay for better care?

RELMAN: It's not that simple. As it is now, new machines or procedures can be widely applied in medicine long before there is evidence

Types of group health plans based on employers surveyed



Rising health-care costs have caused businesses to change the kind of health insurance they provide for their employees. In 1984, most employers provided unmanaged fee-for-service plans (FFS), in which employees choose their own doctors and are reimbursed for all or part of the cost. By 1988, most employers had switched to managed-care plans. In managed fee-for-service, employees still choose their own doctors but the plan attempts to control costs—say, by requiring prior approval for some hospital admissions. At health maintenance organizations (HMOs), employers pay a fixed overall fee, but employees are covered only for treatment approved by the HMO. And at preferred provider organizations (PPOs), the employer contracts with a group of physicians who discount their fees in return for prompt payment and a guaranteed number of patients. Employees must go to participating doctors.

whether they're any good. They're not likely to be widely used if it's clear that they're dangerous, but lots of things that don't hurt people don't help them either. Or maybe they help them, but no more than some cheaper technique already in place.

We have a system now that enables companies to build something, push it, get it into use, and collect from third-party insurers for years before there are any controlled tests of whether it's effective. That contributes both to the high costs of health care and to problems in the quality of care.

TR: This happens frequently?

RELMAN: Wherever you look in medicine, you see examples of this sort of thing. For instance, there are very sophisticated ways of using radioisotopes to visualize various organs. You can give the patient certain substances that localize in, say, the liver or the spleen, and then you can scan over the abdomen and get a picture of the organ. Such tests are technologically very attractive. They have a lot of emotional and technical appeal. They're painless, physically harmless—and very expensive.

These nuclear medicine tests have caught on like wildfire. Every community hospital has machines for doing them. Many physicians, myself included, believe that a great number of the tests are totally unnecessary. There's no evidence that you learn anything in many situations from doing the liver scan or the spleen scan that you can't learn in some other much simpler and less expensive way.

"I tell my colleagues that either they will be part of the solution or else will be viewed as part of the problem."

It's the same with new drugs. The FDA requires a pharmaceutical company, before it's allowed to market a drug, to submit evidence of its safety and efficacy. Well, that's fine. But it may well be that the new drug, which is now going to be marketed very heavily, is no better than an older, less expensive drug. We ought to require studies of relative effectiveness, not just absolute effectiveness.

In surgery, new operations are introduced all the time without convincing evidence that they are effective. For example, an "ECIC bypass" is an operation that connects branches of the internal and external carotid arteries to prevent strokes in people who have cerebral arteriosclerosis. This procedure has been done thousands of times by neurosurgeons and vascular surgeons all over the Western world. The surgeons were convinced that patients with symptoms of impending stroke were much better after this operation. But recently a randomized, controlled trial showed that the operation made no difference.

Changing Medical Practice

TR: What will it take to solve these problems?

RELMAN: One way to moderate the cost explosion is to impose controls from the top—for instance, by setting a ceiling on the national health-care budget. That's what they do in Canada, Great Britain, and many other countries. A central payer—the government—determines how much money society is going to spend on health care. How the doctors and hospitals split up that money is their business. In Canada, doctors are paid on a fee-for-service basis, so there is an economic incentive to provide more services, but the total number of services is limited by the cap on government health spending. In Great Britain, doctors are paid a salary. They have no incentive to provide a particular service, because doing so doesn't increase their income at all.

A system with central control and a single payer has the disadvantage of providing fairly arbitrary caps that are not very sensitive to individual medical needs. However, a centralized system has the advantage that it doesn't interfere with how doctors practice medicine. Within the budgetary constraints, doctors are free to do what they want. There are no second opinions, no utilization review, no government interference with what the doctor does, as there is in this country.

In fact, although doctors make less money in Great Britain and are beholden to the government in a way that American physicians wouldn't like at all, they're much freer in the practice of medicine than U.S. doctors.

TR: That's certainly not how most doctors in this country see the British system. How are U.S. doctors less free?

RELMAN: There are innumerable and growing constraints on the freedom of doctors in this country to make clinical decisions. Insurers say, "We are not going to pay unless you get permission in advance to have the patient admitted to the hospital. We'll tell you how many days we're going to pay for. We're only going to pay you a discounted fraction of your usual fee. And we're going to pay it very slowly."

Doctors are getting more and more frustrated with this kind of environment. The insurers are second-guessing them, looking over their shoulder, asking for more documentation and justification for what doctors do. It's harder and harder to get your bills paid. None of that exists in systems where there is centralized payment.

TR: But doesn't centralized control inevitably mean rationing health care, as in Great Britain?

RELMAN: No, it doesn't. It's true that Great Britain has queues for many elective procedures, and even for certain essential procedures. Also, their physical plant is run-down. Critics of the British system often say, "That's what you get when you have government control," but that misses the point. It's not the government control that's wrong, it's the fact that they spend only about half of what we spend on health care. If the British spent as much per capita as we do, I have no doubt they would have a splendid system that in many ways would be much better than ours.

TR: Do you favor creating a national health system in the United States?

RELMAN: I'm not prepared yet to advocate a single, government-funded program. I believe there is another way to control costs and improve the quality of our health-care system: change the way physicians practice medicine. It's harder, but in my opinion it's much preferable to centralized

control. The reason is that no matter how we finance it, no change in the delivery of health care can occur without a change in what doctors do.

I tell my colleagues who practice medicine that either they will be part of the solution or else they will be viewed by outside forces—by government, payers, business, insurance companies—as part of the problem and will be manipulated against their will. If the medical profession exercised leadership, it could do a lot to solve the problem without any government action.

TR: What would that involve?

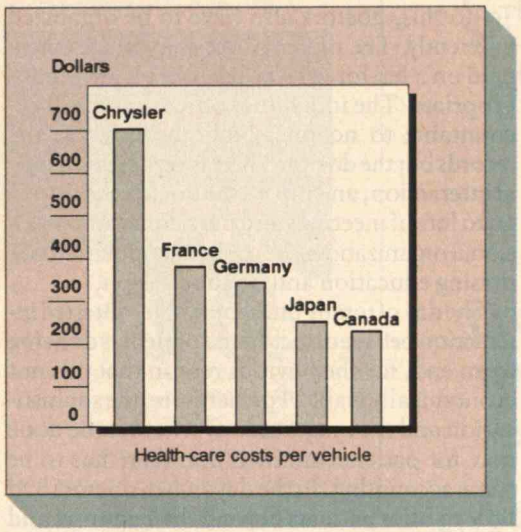
RELMAN: First of all, we need to generate information about new health technologies and the outcomes of current practices—what works and what doesn't—feed that information back to doctors, and integrate it into the payments system. If it becomes clear that certain procedures are worthless, then insurers should say, "We're not going to pay for it." If a technique is still unproven, the insurer can say, "We'll pay for it only if the patients are part of a clinical trial, but we're not going to pay for an experimental procedure when no attempt is being made to evaluate the outcome." The exception might be some extraordinary circumstance like the current AIDS epidemic.

TR: Aren't we doing a lot of technology assessment already?

RELMAN: Sure, it's going on all the time. Every issue of the *Journal* is full of technology assessment. There are studies being done and data bases being assembled. But we've just begun to scratch the surface. And it's not systematic. It's got to be increased by orders of magnitude.

TR: Of course, that will cost even more money.

RELMAN: Yes, it requires a big investment, a national research program. The National Leadership Commission estimates it would take about $500 million per year. But that represents only a few tenths of a percent of what we're already spending for health care. If we invested that amount on research to find out what works and what doesn't, it would pay for itself many times over. We could probably dispense with at least 15 or 20 or maybe even 30 percent of procedures now in use without any loss of effectiveness. We need the equivalent of a national institute that supports this kind of research.



High health-care costs can be a competitive disadvantage for U.S. businesses. For example, the Chrysler Corp. has estimated that for every vehicle it produces, the carmaker and its suppliers spend $700 on employee health insurance. The cost-per-vehicle in other countries ranges from about a third to a half as much.

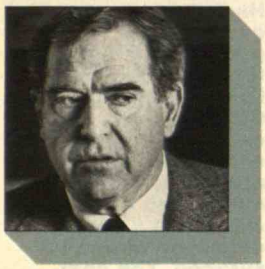
TR: Would the center be federally funded?

RELMAN: Yes, but also privately funded, because all payers are in a position to save money as a result of the information. Another proposal of the National Leadership Commission is to have all insurers pay a fraction of their premiums into a fund that would support such a program.

TR: But doesn't that run the risk of creating a new bureaucracy that would interfere with the doctor-patient relationship?

RELMAN: Whenever I talk about this to doctors, they immediately say, "We don't want cookbook medicine—we don't want to practice according to rigid rules that apply to everybody." That's right. Medicine is a highly personal art, and it has to be applied to each individual in a unique way.

Nevertheless, there are standards of good medical practice in a particular situation or under a certain set of circumstances. You find them all the time in textbooks. The problem is, the textbooks are too full of gray areas. There's just too much ignorance. We need to expand our knowledge of what works and what doesn't and use this new knowledge to develop more comprehensive standards. Doctors should be held to standards—not by government, not by bureaucrats, but by their colleagues.



"The model of the solo, fee-for-service practitioner is no longer appropriate."

To do this, doctors also have to be organized differently. The model of the solo practitioner, paid on a fee-for-service basis, is no longer appropriate. The individual office practice is accountable to no one. Nobody looks at the records but the doctor. There is very little collegial interaction, and unless the doctor chooses to go to lots of meetings and participate in professional organizations, he or she gets minimal continuing education and no supervision.

The day of totally unaccountable, untested interaction between doctor and patient is drawing to an end, for the obvious reason that it is not economically viable. Furthermore, the sophistication and the magnitude of what can be done now for patients are such that there has to be some accounting. In the days when doctors had little to offer patients beyond their counsel and moral support and a few simple drugs and operations, it wasn't necessary to change the practice of medicine. But we're now talking about procedures that are enormously expensive and sometimes terribly dangerous. Big choices have to be made. And society has a much greater stake in health care than ever before.

I think we're going to see a continuing shift toward doctors practicing in groups and toward more salaried positions. According to some recent AMA surveys, about 40 percent of all new physicians are making their living primarily from salaries.

TR: Do you mean in HMOs?

RELMAN: Not only in HMOs. Also in group practices which bill on a fee-for-service basis but pay their physicians a salary. And many large teaching hospitals now have group practices on the premises. The point is that in such group arrangements, what doctors do is in plain view of their colleagues. There are meetings, conferences, quality-assurance mechanisms in play all the time. I think that trend offers us the best chance of controlling costs while preserving quality.

TR: This might be called the "collectivization" of the medical profession.

RELMAN: It's a balance. The interaction between doctor and patient is very personal. It's not a collective experience. It cannot be standardized. But that doesn't mean that doctors cannot be held to certain standards.

My preferred model would be this: doctors practicing medicine in full view of their colleagues, responsive to the best available information, keeping records that are going to be reviewed by their colleagues. That kind of practice will enable the results of technology assessment to be fed back to doctors more effectively. And if their income is not as dependent on the number of services they provide, doctors will be more conservative in their use of resources.

In fact, that's what goes on in the best clinics and teaching hospitals. Good doctors never hesitate to talk about what they are doing, to share their experiences with their colleagues, and to learn from them and modify their procedures accordingly. Under those circumstances, the best kind of medicine is practiced. And it does not prevent the personal commitment to the patient.

Now, I'm not saying that fee-for-service should be outlawed. But we should provide incentives that make group practice and salaried arrangements more attractive to young doctors and to patients. Because in the long run, that will be the model for providing high-quality health care to everybody who needs it, at an affordable price.

Possibilities for Reform

TR: There have been a lot of recent proposals for reforming the health-care system. What is likely to happen in the years ahead?

RELMAN: I think there will be a movement to simplify the payment system—both to control costs and to provide insurance for those who don't have it. But I think the changes will be incremental, the idea being to preserve as much of the current financing structure as possible.

As we experiment with various changes, we may eventually head toward a Canadian-style system—centralized government control. But I think it is politically very unlikely that we will do it now. For one thing, all the vested interests who are making money now—insurers, management consultants, the marketing people, some hospitals, for-profit companies, and a great many physicians—will resist major changes in the system. But if after a certain amount of piecemeal change it becomes clear that the problem require drastic action, then the federal government will step in. I don't think the vested interests can quire drastic action, then the federal government will step in. I don't think the vested interests can

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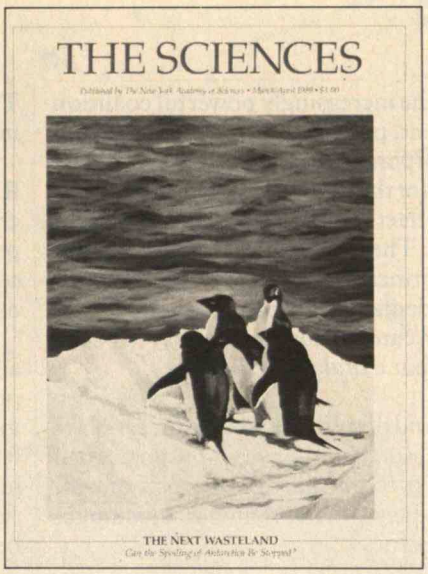

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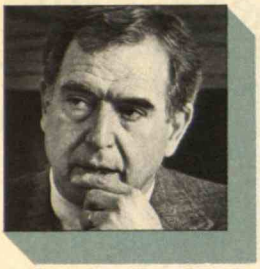


"Large corporations may end up demanding government control as the only way to put the brake on costs."

stand up to the increasingly powerful coalition of government, public opinion, and business.

The big corporations in this country are fed up with paying for the present system and will have a powerful effect in shaping our future health-care system. They may object to government control on principle. But, ironically, business may end up demanding more government control of health care because it turns out to be the only way to put a brake on costs.

TR: What kind of role should consumers play? For instance, some of the recent proposals call for consumers to pay part of the costs out-of-pocket, the theory being that this encourages cost-consciousness.

RELMAN: I think one has to be very careful about co-payment or deductibles. In principle, they make sense: when it's free you want it all, and when you have to pay you think twice. That works all right for middle-income people. But if you're really poor, it stops you from getting the health care you really need. And if you're rich, the deductible doesn't work either, because who cares? The basic problem is that the patient doesn't always know what he or she really needs. And if it's going to cost $200 more, a poor patient may not want a procedure that is medically necessary.

Patients have to participate in decisions about their own health, but there are limits. When you're really sick and in fear for your life, there's no way you can rationally decide what tests and treatments you should or shouldn't have. You have to depend on your doctor.

TR: Isn't it in precisely this situation that people tend to want everything?

RELMAN: Exactly. And if doctors are afraid of being sued or don't have the support of their colleagues, or if the information isn't available to justify professional decisions, then they are going to be buffeted by public opinion and by the opinion of their patients. But when they have good information, and when they work in a collegial situation in accordance with accepted medical standards, doctors are in a much better position to say to the patient, "This is not likely to help, this doesn't make sense, we shouldn't do this," or "This is what we should do." The doctor who feels he or she has got to do whatever the patient wants is not a very good doctor.

TR: Presumably, any reform of the system would involve reform of malpractice.

RELMAN: Absolutely. Of course, the liability crisis is felt in all walks of life. But it's especially pernicious in medicine, because it not only has economic consequences but also affects the kind of health care people receive.

The economic costs are hard to evaluate. In addition to the $5 billion or so physicians spend on malpractice premiums, there's the immeasurable cost of the practice style that results from fear of litigation. I've seen estimates of $20 billion, but it's just a guess. There is no question that a lot of what doctors do is based on fear of being sued.

The basic problem is that people can be compensated for damages only if the blame can be placed at somebody's feet. That's not fair to the patients or to the doctors. A lot of patients are damaged as a result of being in the hospital or being in the health-care system. There are economic and other serious losses for which they are entitled to some compensation but that aren't really anybody's fault.

Take drug reactions. They are extremely common. Some can be very serious, even crippling. Doctors can avoid some drug reactions by using their medical knowledge, but others are completely unforeseeable. The patient should be compensated, but nobody was at fault.

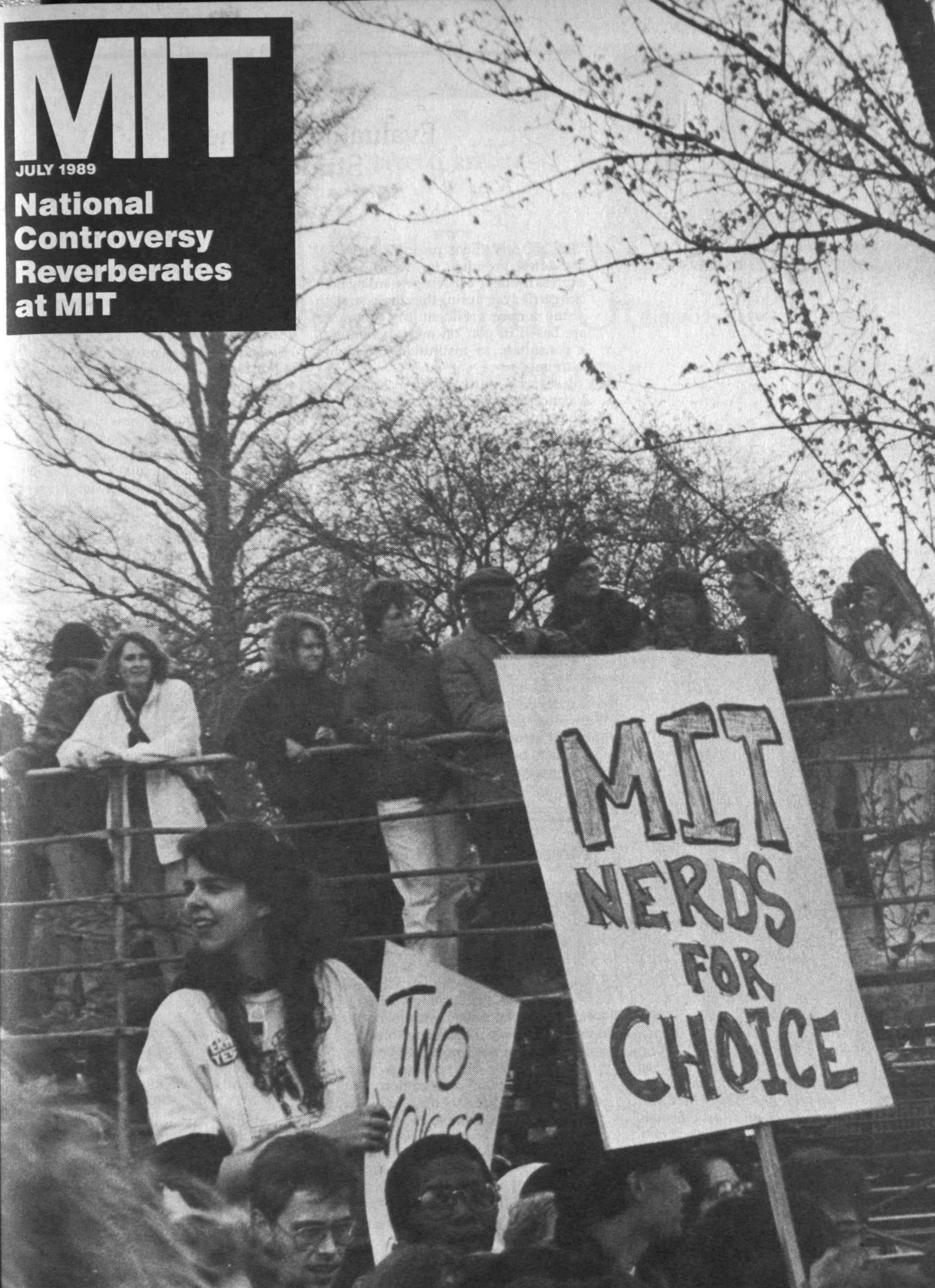
The way the system is, you have to threaten to sue, or actually sue, a doctor or a hospital. Then, the decision as to whether the doctor or the hospital was at fault is made by a system that is not well designed to answer the key medical questions. You have a lay jury being entertained by lawyers who are trying to make a dramatic case. You have paid professional witnesses. Scientific facts have very little to do with it. What's more, the awards are often outrageously high. But even when patients win—and they don't very often—they end up with a small fraction of the award. It's a very bad system.

So we have to separate two different questions. One is whether the patient was damaged, and what's fair compensation. Here we need some kind of no-fault insurance system. The other question is whether there was malpractice. The decision should be made by a system that is supervised and monitored by the state but run by professionals. Doctors and hospitals accused of malpractice should be judged by their peers, not by a jury. ■

MIT

JULY 1989

National Controversy Reverberates at MIT



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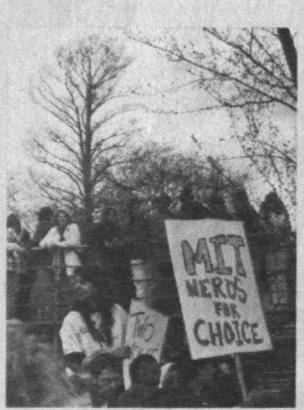


COVER:
At least one of their posters was humorous, but the issue that drew more than four busloads of MIT students, staff, and faculty to a demonstration in Washington in April is one of the most divisive—and therefore the most serious—facing this country: abortion rights. (Photo by Georgina Maldonado, '91.)

LETTERS

Evaluating Teachers, Students

With the imminent prospect of selecting a new president for MIT, I wish to express my deep concerns regarding policies carried out during the administration of the current president. My comments are based in part on my experience as a consultant to institutions of higher learning.

It seems to me that over the past 40 years a concerted attempt has been made to divert MIT from an Institute of Technology with excellence as its overriding objective to a mediocre university, of which there are already too many. I'd like to see this trend reversed before it's too late.

I have several concerns; I will mention two here: the teaching versus research, "publish or perish" syndrome, and the pass/fail system of grading.

Concerning my first point, the evaluation of professors: Good teachers and good researchers don't necessarily come in the same package. The requisite skills are quite different. Both sets of skills must be carefully honed through years of practice. To force all professors through the research and publish mold in many instances does a disservice to both the individual and the Institute. This policy clearly states that only research counts if one is to be promoted.

Consequently, there aren't nearly as many good teachers, and the result is not as many good students as there might be. Inspiring teachers inspire all students toward doing their best, toward excellence.

My recommendation is that after two years with the Institute, a faculty member be asked to express a preference for teaching or research. All future performance evaluations would be made strictly on the stated preference.

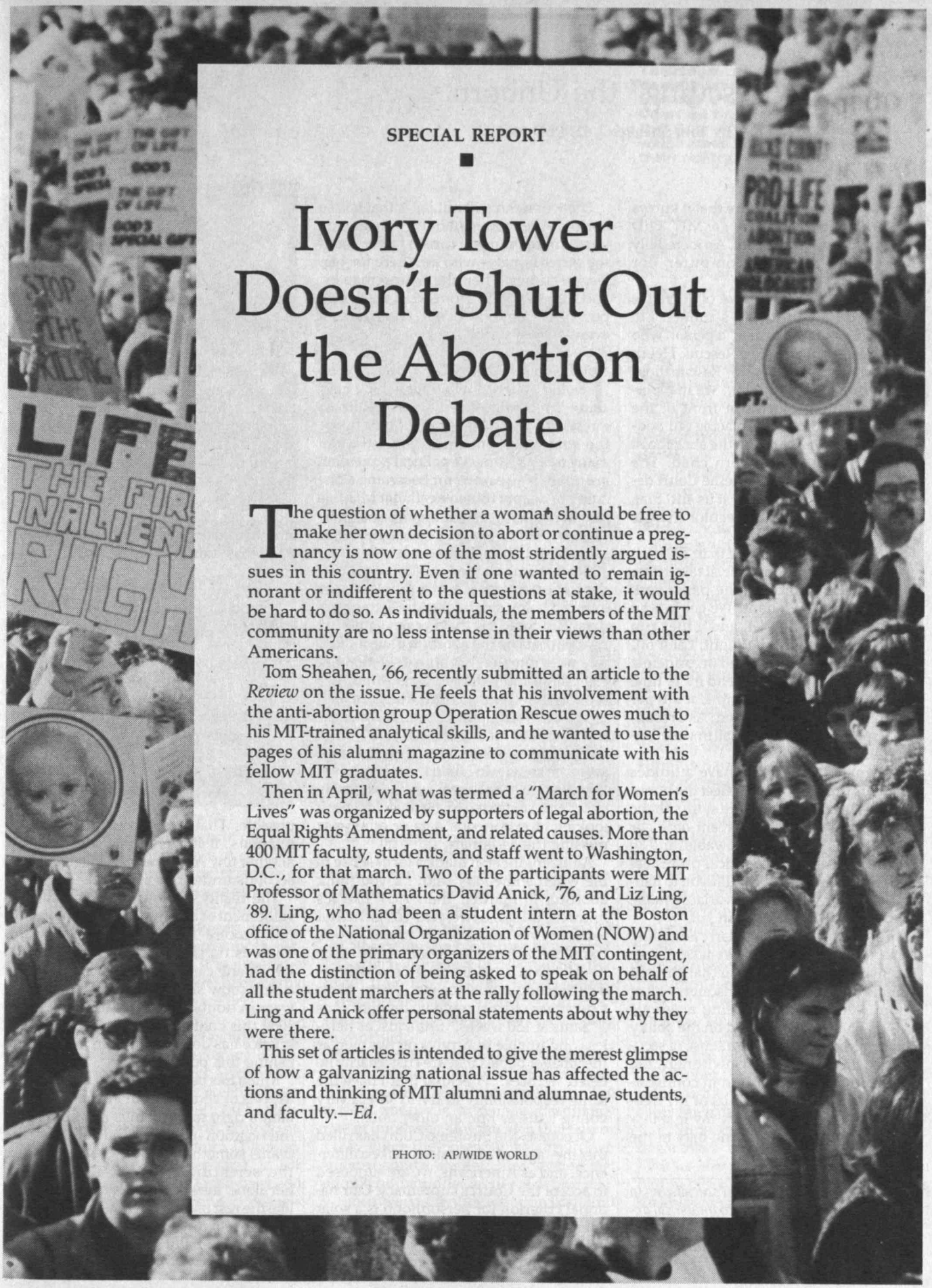
The second point seems deceptively simple. With the pass/fail grading system, the carrot has been removed and the stick remains. Under any grading system, poor students fail and exceptionally bright students do well. But the majority of students are neither, and they need a carrot, some incentive, to do their best. Pass is mediocre and does nothing to differentiate the below-average, average, and above-average student.

In a very real sense, the pass/fail grading system is somewhere between communistic and socialistic in its logic—a far cry from capitalism, in which the real world differentiates our value to our associates through compensation. The world is learning that neither communism not socialism works—a lesson, it seems, MIT has yet to learn.

JAMES O. JUSTICE,'47
Palm Desert, Calif.

Farewell to an Old Friend

Walter Muther, '13, the Institute's oldest active alumnus and class agent, died eleven months shy of his 100th birthday on April 4, 1989. Many will remember the enthusiastic gentleman with the hearing-aid headset who rarely missed an alumni function in the Massachusetts area. His son-in-law, in a note to the Alumni Association, sent his "heartfelt thanks for the seventy-six years of fun, information, and good fellowship Walter was afforded by your association and MIT itself, of which he was justly and immensely proud." The Technology Day Luncheon won't be the same without him.



SPECIAL REPORT

Ivory Tower Doesn't Shut Out the Abortion Debate

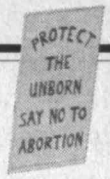
The question of whether a woman should be free to make her own decision to abort or continue a pregnancy is now one of the most stridently argued issues in this country. Even if one wanted to remain ignorant or indifferent to the questions at stake, it would be hard to do so. As individuals, the members of the MIT community are no less intense in their views than other Americans.

Tom Sheahen, '66, recently submitted an article to the *Review* on the issue. He feels that his involvement with the anti-abortion group Operation Rescue owes much to his MIT-trained analytical skills, and he wanted to use the pages of his alumni magazine to communicate with his fellow MIT graduates.

Then in April, what was termed a "March for Women's Lives" was organized by supporters of legal abortion, the Equal Rights Amendment, and related causes. More than 400 MIT faculty, students, and staff went to Washington, D.C., for that march. Two of the participants were MIT Professor of Mathematics David Anick, '76, and Liz Ling, '89. Ling, who had been a student intern at the Boston office of the National Organization of Women (NOW) and was one of the primary organizers of the MIT contingent, had the distinction of being asked to speak on behalf of all the student marchers at the rally following the march. Ling and Anick offer personal statements about why they were there.

This set of articles is intended to give the merest glimpse of how a galvanizing national issue has affected the actions and thinking of MIT alumni and alumnae, students, and faculty.—*Ed.*

PHOTO: AP/WIDE WORLD



"Rescuing" the Unborn

By Tom Sheahen, '62, PhD '66

The world is pretty sure that it knows what sort of things an MIT PhD might do to land in jail. An incredibly clever bank heist by computer, for example.

But nothing so grandiose or lucrative sent me on a trip to the slammer. I'm what's known as a "rescuer," a person who participates in Operation Rescue. Heeding the words in the Bible to "Rescue those being dragged to slaughter," we in Operation Rescue sit quietly in front of the doors of abortion clinics, placing our bodies in the pathway between the abortionist and the victim, the unborn child. The police, upholding the Supreme Court decision of Roe vs. Wade, arrest us and drag us away, and the local prosecutor charges us with "criminal trespass."

Since there are often more than 100 such rescuers at an abortion clinic, it takes time for the police to process the paperwork charging each defendant. We get to wait in jail while they do that, and if they run past 5:00 PM, we stay overnight. Later on, after a trial, those who stand on principle and refuse to pay a fine spend more time in jail, with the meter running at $10 per day until the fine is amortized. As a result, I have spent several days in jail in Washington, D.C.

The guards in the jails have attitudes toward us that pretty well reflect the population at large: 10 percent are sympathetic and are extra polite, 10 percent hate our guts and are as nasty as allowable, and 80 percent just see us as political protesters who aren't going to be very difficult to handle. However, the rules invariably make sure that it's no fun to be in jail.

Curiously, it was particularly annoying to me to have my shoelaces taken away (ostensibly on the grounds that I might strangle one of my fellow prisoners—all of whom were pro-lifers). Being a serious runner, I have always relied on the ability to jog anywhere to give me a sense of security and independence. Unwittingly, the jailers found my hot button in confiscating my shoelaces. The denial of my freedom was conveyed more by my inability to walk properly than by the bars in the cell.

The worst thing about jail is that it is so boring. After about an hour, you already know more than you care to know about the other inmates who are there for big-league crimes. Then the hours creep by, and there's nothing to read. (I wasn't expecting the *Physical Review Letters*, but not even a newspaper?)

It's certainly fair to ask why anyone would go to jail when they don't have to. In particular, it's reasonable to question why an MIT grad would choose the route of silent, inert protest when many other avenues of political expression are open. My reasons for becoming a rescuer are deeply rooted in all that MIT has taught me, and it seems appropriate to explain myself to my MIT colleagues.

I believe that MIT gives its students an ability to focus on the essentials, to isolate the important aspects of a problem, and to avoid being sidetracked by extraneous data. You could say that I began gathering my own data on the abortion issue in 1967, when I wrote the first of many letters-to-the-editor and letters to legislators. All I have to show for my efforts are more than 50 polite form letters from Congress thanking me for my views. Many other writers and speakers have been measurably more convincing than I, but I could see that the rate of change was still extremely slow. This suggested to me that I had been looking at extraneous data or otherwise missing the essentials.

As an engineer, it made a lot of sense to me when somebody said, "If you think abortion is murder, then ACT like it's murder." If I saw a two-year-old girl about to drown in a neighbor's swimming pool, I wouldn't write a letter to somebody about it—I'd dive in to rescue her. I'd probably get a citizenship medal for my efforts. Now, a two-year-old girl could be thought of as a "fetus at 150 weeks." She's just as helpless and unable to survive on her own as the smaller babies that are customarily labeled "fetuses." I decided that I have the same responsibility to try to save a very young fetus as I do an older one.

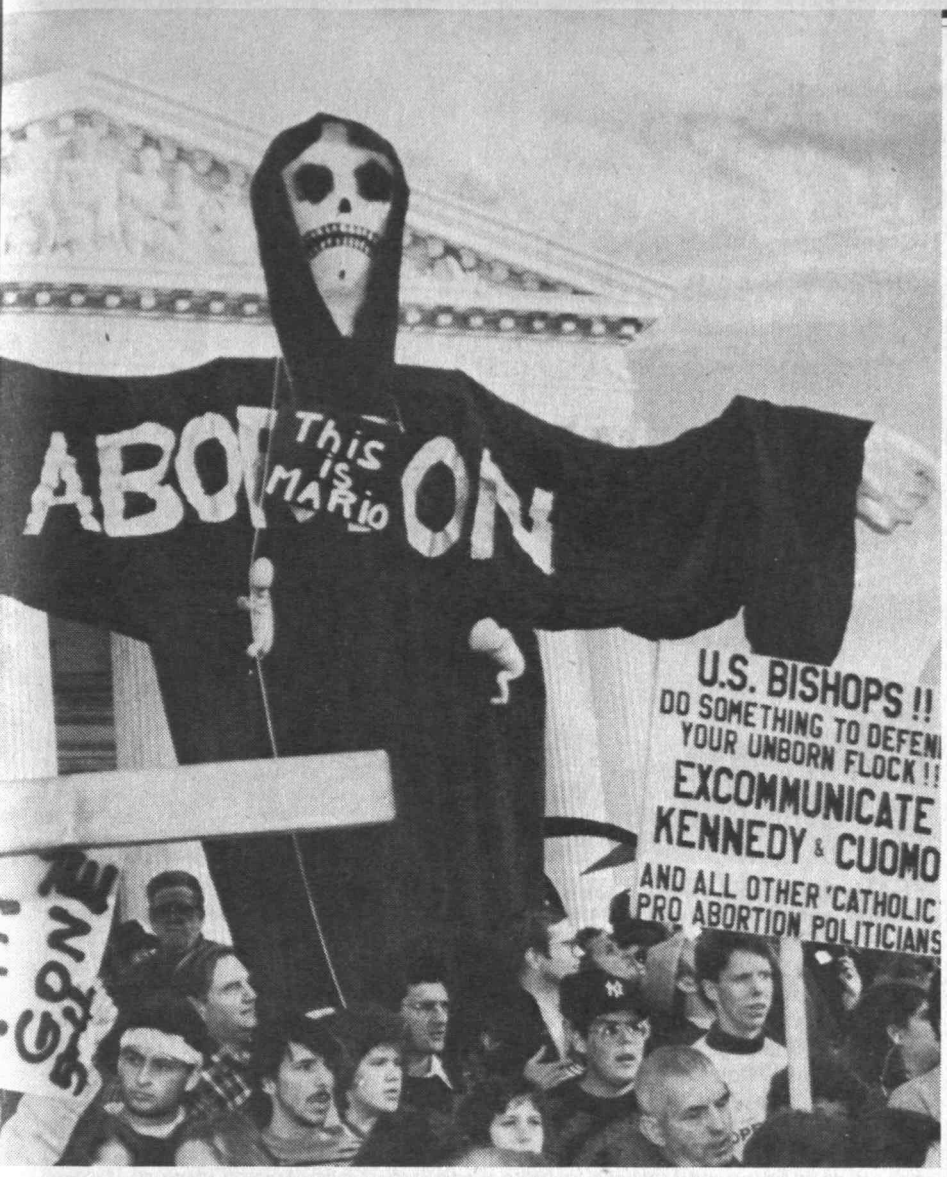
Of course, the Supreme Court has ruled that the "age" of a fetus does make a difference, and as Americans, we are supposed to accept the Court's supremacy. Our national criterion for personhood is a solar energy criterion: If sunlight can reach you, you're safe; but if you are still inside the womb, you're just property, entirely disposable. That is so absurd it would be hilarious, if it weren't for the fact that another tiny American gets killed every 21 seconds under this standard.

The reality, of course, is that the development of a human being is a continuous process from conception onward. There is no clear-cut transition point at which one can say, "Before she was just a blob; now she's human." If some folks were in doubt about this fact in 1973, by 1989 this continuity is obvious. Medical science has done a thorough job of establishing this point.

Much has been written on the religious aspects of abortion. But I believe that the baby's right to life comes not from some intervention in which God suddenly implants something called a soul, but from the scientific fact that if you leave her alone, inevitably the baby will turn out like the rest of us. If ever there was an area where religion and science agree, it's on the statement that human life is a continuum.

PHOTO: AP/WIDE WORLD

TOM SHEAHEN is a physicist specializing in converting research results into industrial applications of technology. He is working on a book entitled Industrial Superconductivity: Practical Applications.



Thousands of anti-abortion demonstrators gather in front of the U.S. Supreme Court on the anniversary of the Roe v. Wade decision which made abortion legal in this country.

Who has the right to interrupt that continuum, that baby's process of development? We can all accept the principle of self-defense; if the baby is going to die anyway, there is no point taking the mother along, too. Yet in all other cases, no matter how gloomy the circumstances surrounding the pregnancy, it is never the baby's fault. So why must the baby be the one to pay the ultimate price?

This may all be good reasoning, but still, why "sit in"? Becoming an object for removal from the sidewalk is hardly consistent with the creative energies normally associated with MIT graduates. For the overall reasoning, I can do no better than cite the "Letter from a Birmingham Jail" by Martin Luther King, Jr. For myself, a big contributing factor has been the utter frustration of trying to discuss this issue in polite society.

The initial obstacle is that very few people know that abortion is legal for the full nine months. However horrified we may be by a ninth-month abortion, it *is* legal.

The Alan Guttmacher Institute (the research arm of Planned Parenthood) has testified that 97 percent of abortions are "because the mother didn't want to be pregnant at that time." When I bring this up, invariably the conversation is diverted to the 0.01 percent of pregnancies that result from forcible rape. I feel that rescuers are expected to solve every other social problem in America before attending to abortion.

The "quality of life" argument is another way of deflecting attention from the essential issue. Certainly one component of the cycle of poverty is the teenage pregnancy rate in the slums. But the idea that you or I may judge the potential "quality" of an unborn child's life and then decide if it should be continued or not is deplorable.

Since every scientific criterion I can find tells me that abortion is murder, I think it's time to act like abortion is murder. But if that is so, then why not counterattack, with the bombing of clinics, etc.? Because nonviolence is the only possible path to success. Violence begets violence, as we have all seen in the Middle East. The cycle continues until someone forgives the attacker and refuses to retaliate. The decision to absorb violence and end the cycle is nonviolence.

Spending time in jail is a thoroughly disagreeable experience. Sitting on a hot sidewalk, waiting to find out whether these particular local police are likely to wrench my arms painfully behind my back as they haul me off to the paddy wagon is also pretty unpleasant. However, it is survivable, and it is made easier by remembering what happens to the unborn baby if we don't act.

I am also inspired to continue by the example of Joan Andrews, probably the most committed of the rescuers. Eventually, she was sentenced to five years in prison on trumped-up burglary charges and was treated harshly during three and a half years in a maximum security prison. Joan Andrews shares the vulnerability of the unborn, and her very vulnerability functions as a spotlight upon the denial of basic human rights that unborn babies suffer. Nothing that happens to me compares with her sacrifices.

My intention and that of other rescuers is certainly to bring a halt to the abortion industry. But we are not going to do this merely by blocking the doors of abortion clinics; there are way too many such doors. Rather, by forcing the system to deal with us as surrogates for the unborn, by making that vulnerability clear, we expect to wake the American people up to what is really going on inside the abortion clinics: A real human being is being denied all human rights, is being treated as property, is being killed for the convenience of the "owner." Once that point is understood, the American people will be good enough to stop the killing.

One of my activities as an MIT alumnus involves interviewing high school applicants for admission to the Institute. This year, the suggested essay topic for would-be members of the Class of 1993 was this: "Tell us about an opinion that you have had to defend or an incident in your life that placed you in conflict with the beliefs of a majority of people and explain how this affected your value system." I'm glad I didn't have to answer that one in the late 1950s, but I am happy to answer it now. □

Big Issues Brought Home

By Elizabeth Ling, '89

Liz Ling (front row, right), shown marching with other members of the MIT community, spoke on behalf of all the students at the April "March for Women's Lives" in Washington, D.C.

On April 9, the March for Women's Equality and Women's Lives drew about half a million people to Washington, D.C. The nation witnessed the huge support for choice. But it was in the months preceding that day that MIT saw the revitalization of its feminist community, as it marshalled its energies to support, advertise, and organize for the march. Those few months saw people from a reputedly apathetic environment stand up and take action to support their rights.

I was one MIT organizer who saw the project from its beginning stages to its culmination. People both inside and outside MIT are surprised that I am politically involved and asked how it happened.

Activism was a word that made me nervous. ("No, I'm not an activist, I just believe that this is an important issue.") But I came to realize that activism comes from active, and that if I only passively defended my rights, I'd lose them.

When I became interested in women's issues as a result of my women's studies class at MIT, I decided that the best vehicle for really understanding the women's movement would be to get behind the scenes, see how a group fighting for political, economic, and social equality for women operated. So I took an internship with the Boston chapter of the National Organization for Women (NOW), which was then beginning to organize nationwide for the march.

When Boston NOW was planning its mobilization of Boston-area colleges, it almost decided not to bother trying to recruit marchers from MIT. NOW subscribed to the common assumption that MIT students are politically and socially conservative, that they prefer to hide in their labs and "tool" rather than get up and make a statement. I wasn't so sure they were wrong, but I and a few other students decided to stir up support for the march.

A handful of pro-choice people set up a table in Lobby 10 where supporters could sign up for the march. We thought we would be really lucky if we had enough people from MIT to fill two buses. We argued for quite a while about whether to special-order 50 or 100 "MIT for Choice" T-shirts to sell to support the cost of the buses. We finally made what seemed like a risky decision—we ordered 100. We ultimately sold about 500 T-shirts, and we filled almost five buses.

As the mobilization for the march came together, there were more and more letters in *The Tech*—on both sides of the issue—and we've heard growing discussion among the MIT population. We've seen the big issues brought home.

The response at MIT was characteristic of that across the nation. People have become afraid, as they realize that rights they have taken for granted may soon be taken away. Fear of loss is a powerful motivator.

There are levels on which the abortion issue affects everyone, not just women of child-bearing age. For me and countless other pro-choice advocates, it is an issue of control over one's own body—hence the many march posters reading: "This body is my body." We have control over where we live, over the kind of work we do. We have control over what we ultimately think and say. But if we don't make the decisions about what happens to our bodies, what is the value of any other freedom?

If government has the right to decide that you *will not* have an abortion, what stops it from deciding at some point that the prevailing political priorities dictate that you *must* have an abortion? Where does government legislation of your body stop?

Anti-choice advocates often talk of the "right to life" of the "independent being" that is a fetus. But a fetus is a dependent being, dependent on a woman. Does the right to life also include the "right to use another person's body"?

Pro-choice does not mean pro-abortion. Nobody *wants* to have an abortion—a procedure with mental, emotional, and often physical costs for the pregnant woman. And it is certainly not appropriate as a form of birth control (prompting many pro-choice advocates and groups to be advocates of reliable, readily available birth control and sex education). But since it is an essential option for pregnant women, it is vital that abortion be legal and as medically safe as possible.

It has been said of my generation that, because so many of our battles have been fought for us, we don't appreciate what we have, we don't care. That is not what I believe, because that is not what I see. What I see on the MIT campus is a revitalized feminist community, surprising the campus and surprising itself. What I saw in Washington were delegations from more than 500 colleges and high schools, representing a generation that is learning how precious and tenuous are the rights that we have inherited. Our rights are on the line, and these battles are now our battles. □

ELIZABETH LING received a bachelor's degree in management in June.

PHOTO: GEORGINA MALDONADO, '91

Lessons My Friends Have Taught Me

By David Anick, '76, PhD '80

On April 9, I joined other MIT students, faculty, and staff who arrived in Washington, D.C., for a rally in support of a woman's right to choose abortion. My thoughts on this subject are grounded as much in the experiences of my friends as in philosophical considerations.

"Life is interwoven in a dance of death, the limiting factor that sustains the possibility of new life," in the words of spiritual writer Starhawk. "To value life as an untempered absolute . . . is to maintain the right of every cancer cell to reproduce blindly, of every sperm and every egg to unite to form a new embryo . . . to populate the world endlessly." A mature pro-life stance acknowledges the necessity of death, and encourages wise judgments about how to intervene on behalf of life.

The Latin root of "to decide" means "to cut off." Each time we say "yes," we also implicitly say "no" to dozens of other possible paths. It is an inescapable fact that we must make decisions—whether by design or default—about reproducing ourselves. The anti-abortionists would have us say "yes" to every pregnancy, and in so doing, always say "no" to the alternatives. In particular situations, however, rejecting a pregnancy might better serve a life-furthering philosophy. A rigid "pro-life" position may actually defeat the very values it is intended to advance. This lesson was brought home to me through the stories of five women I know personally.

Margaret (not her real name) says her diaphragm failed at "the worst possible time" in her life. In the end, she accepted her fiance's urgings not to abort the pregnancy, but their engagement did not survive the stressful situation. She delivered a healthy baby, but there was no wedding. In spite of all the demands he places on her, Margaret's child is now a delight to her and to all who meet him.

Margaret was particularly fortunate: she could fall back on a supportive network of family and friends, a flexible work schedule, and her own efficient self-discipline. What's more, she did have a choice; having *chosen* to give birth, she believes, made the experience one of joy and determination rather than resentment and despair.

Another friend, Alice, married at nineteen a man who adamantly rejected birth control. She had five daughters in as many years. With her sixth pregnancy, Alice realized that she had to preserve what energy and sanity she had for the children already born. "If I had said 'yes' to the sixth," she explained to me, "I would have gone crazy. And then I'd actually be saying 'no' to all six of them." Without her husband's knowledge, Alice obtained an abortion (illegal at the time) and began using the Pill. I cannot imagine an action more courageous and life-enhancing—or more fundamentally moral—than hers.

Barbara was an MIT undergraduate when she became pregnant: two forms of birth control failed. Uncertain of support from family and friends, having already broken up with her boyfriend before discovering her condition, and determined to continue her education, she terminated her pregnancy.

In this case, weighing the life-affirming potential of the "yes" and "no" positions is more problematic. Rigid anti-abortionists would insist that the embryo got short shrift here. Those who know her, however, recognize that Barbara has been able to accomplish a lot of good through her work as a community organizer and probably saved lives, only because she was not overwhelmed by the physical and emotional demands of single parenthood.

Barbara may have made the wrong choice, although I don't think so. But the real question is, who should choose? Can a set of impersonal, bureaucratic laws and legal judgments be counted on to produce a better ethical decision than the individuals directly involved?

Ruth was also unprepared for parenthood at the time she accidentally conceived; but she believed that, for herself, abortion would be murder. She made plans to have the baby and immediately started interviewing potential adoptive parents. Throughout her pregnancy, she resisted any temptation to think of the child-to-be as her own. It was, rather, something that had been temporarily entrusted to her care.

Ruth was blessed with a deep self-knowledge, a supportive boyfriend, and a problem-free pregnancy. While her example is inspiring, adoption is no cure-all. The Baby M surrogate-mother case tragically demonstrates that even a woman intending from day one to surrender her offspring can experience an unseverable bond when the moment arrives. Women who have reason to believe that this is how they would react cannot realistically be asked to consider adoption. And for someone in a marriage like Alice's, it would have been out of the question.

Another friend who ultimately rejected abortion was Jill, even though the medical complications of her pregnancy required her to be in bed for six months or risk nearly certain miscarriage. With a husband who could support her, a deep desire for children, and a lot of reading to catch up on, she coped astonishingly well. Had she been single, poor, or subject to severe depression when isolated, her situation could have been intolerable instead of merely difficult. Could anyone but Jill herself have made the decision about how much she could and should sacrifice to "save" a fetus incapable of living for even a few minutes outside her body?

For me, these stories illustrate how individual and complex is the decision whether to continue a pregnancy. Even if one sincerely believes abortion to be murder—a position I honor but do not hold—the courts and legislatures are probably the worst possible mechanisms for preventing it. Do we really want our jails full of women whose only crime was to lose at the birth control lottery? Do we want the police investigating as possible murder the circumstances of any woman who has the misfortune to miscarry? And aren't there enough unwanted children already here—children with AIDS, handicapped children, older foster children—who have first claim on society's limited resources?

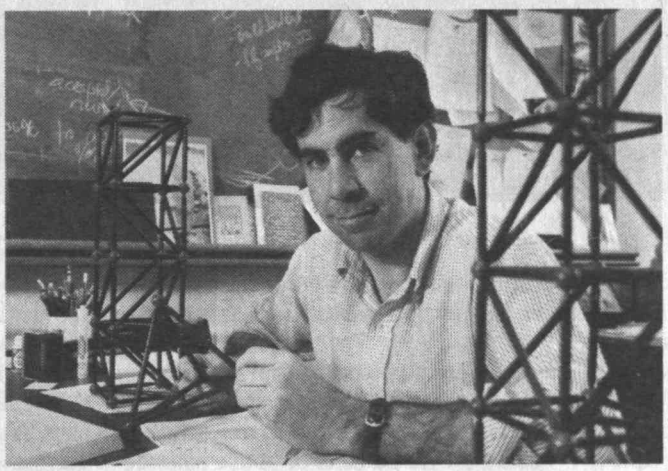
I applaud those who seek to protect and enhance human life. But blockading health clinics and lobbying to alter abortion laws will not promote this goal. Instead of showing up en masse at Planned Parenthood clinics, why don't the Operation Rescue folks spend a day handing out condoms at a local high school? It would greatly improve their effectiveness in preventing abortions. Instead of harassing women whom they've never met before, why not invest the time in getting to know a mother on Aid to Families with Dependent Children (AFDC), helping her find a job and arrange day care? And why not go after the real killers, like agricultural poisons, groundwater pollution, and radiation leaks, which cause thousands of birth defects and spontaneous abortions in this country every year? □

DAVID ANICK is an associate professor of mathematics at MIT.

Graduate student Nesbitt Hagood, '85, tightens an "active member," a section of truss that will enable a space structure to cope with stresses by changing shape in response to a control signal.

SERC Promotes a Heavenly Union

BY STEVE NADIS



Plastic models help Professor Ed Crawley, '76, and colleagues at the Space Engineering Research Center (SERC) test their ideas for controlled space structures.

The idea of scientists and engineers working together to design large-scale technological projects, like space missions, hardly seems novel. Yet it happens all too rarely, even at MIT. In the vast majority of cases, scientists conceive a plan, and engineers—mainly from large aerospace companies—are brought in to implement it.

A one-year-old center based at MIT and funded by NASA is designed to change the traditional pattern. The Space Engineering Research Center (SERC) will link research engineers, scientists, and industry together at the earliest stages to develop the platforms and structures needed for future missions in space science and astronomy.

"It's the first collaboration of this kind at MIT, although we've attempted to bring it about in the past," says Associate Dean of Engineering Jack Kerrebrock, chairman of SERC's Steering Committee. "By collaboration, I mean engineers creating capabilities that are enabling of science, and scientists proposing tasks that lead to the advancement of engineering."

"Who knows? If we can get it going here at MIT, maybe the idea will spread to NASA," Kerrebrock says.

Physics Professor Claude Canizares, chairman of SERC's Science Advisory Committee, agrees: "There's been relatively little connection between scientists and the Aeronautics and Astronautics Department at MIT. We've each gone our separate ways. Occasional collaborations have occurred by chance, not design."

Another distinguishing feature is SERC's long-range approach to spacecraft. "It's rare in the space science field to look ahead 10 or 20 years to see what kind of structures, or control of structures, we'll need to do our job," Canizares says.

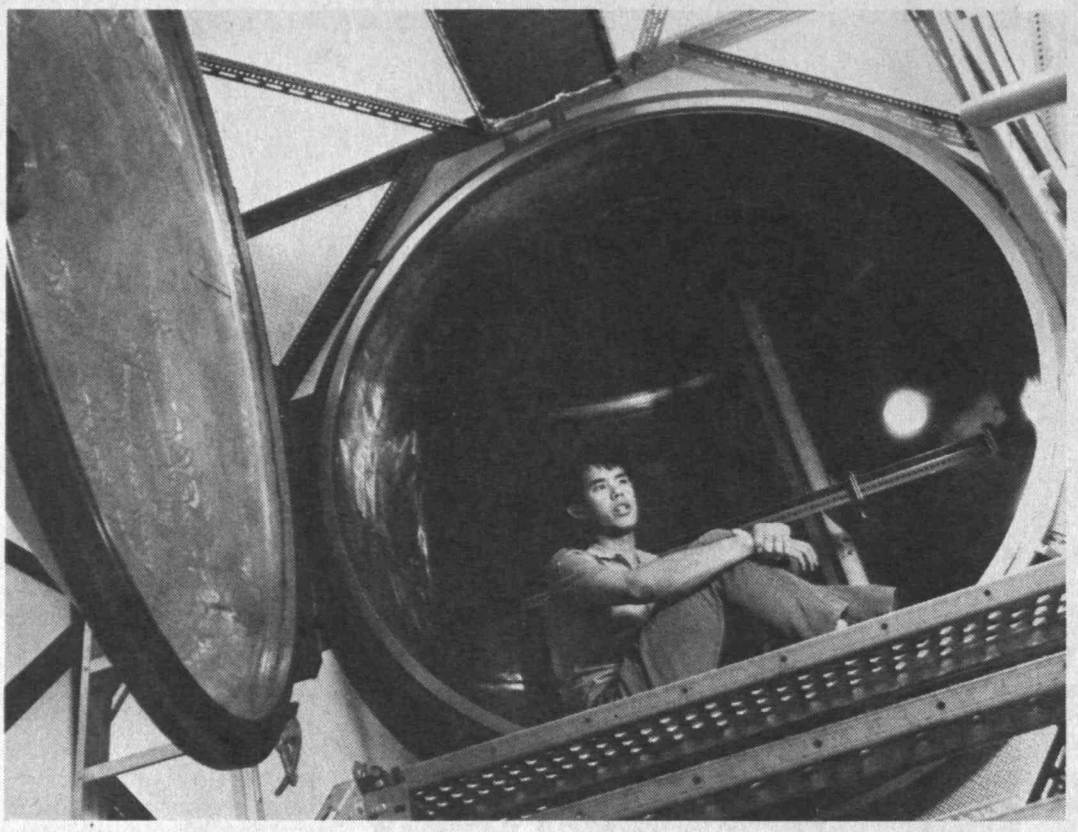
SERC came into being in May 1988, when NASA selected MIT and eight other universities to conduct research in critical areas of space engineering and technology. The MIT center—which is based primarily in the Department of Aeronautics and Astronautics—will receive about $1.5 million per year for at least five years to support the work of some 10 faculty members, 30 graduate students, and assorted undergraduates.

SERC's first major project was a broad review of the technical requirements of planned space missions. They include the Earth Observing System, a "polar orbiting platform," or satellite, loaded with numerous sensing devices to monitor the earth's atmosphere, land, and seas; space-based x-ray, gamma-ray, and radio telescopes; gravity wave detectors; and a network of orbiting telescopes called an "optical interferometer."

Experiments are under way to test individual components needed for advanced space structures. Broader, integrated experiments are expected to begin next fall. In the summer of 1991, a SERC microgravity experiment is scheduled to fly on the space shuttle, and an experiment for the pro-

STEVE NADIS is a frequent contributor to Technology Review.

PHOTOS: PAULA LERNER



Joe Ting, '88, waits for the next project for the ASTROVAC, a testing machine that simulates the vacuum and zero gravity of space.

posed space station is also being planned.

SERC's primary objective is to develop the new engineering discipline of "controlled structures technology," or CST, while tying this effort to specific missions in the space program.

In the past, the engineering tasks of designing structures and implementing control have been separate. A structural engineer, for example, might design a rocket to meet some established criteria and then develop models to predict how it will behave under different conditions. The control engineer, on the other hand, would employ an array of sensors to monitor the state of that system, using the information to make necessary corrections. Control mechanisms of this type include auto-pilot devices on planes or "attitude stabilization systems" designed to keep satellites in a desired orbit.

"The way it typically works in the airplane industry is that one person designs the craft for strength, the other looks to see if vibrations will be a problem," explains Professor James Mar, '41, co-director of SERC. "We want to start from scratch, looking at the entire problem at the same time."

There are two general ways to build a space platform with the precision needed to meet the exacting requirements of space science missions. One would be to build a structure so rigid that it maintains the same shape under all foreseeable conditions. A more practical and economical approach, according to Professor Ed Crawley, '76, co-director of SERC, is to "build the structure aproximately the right shape, with an active control system to make sure it does what you want it to do."

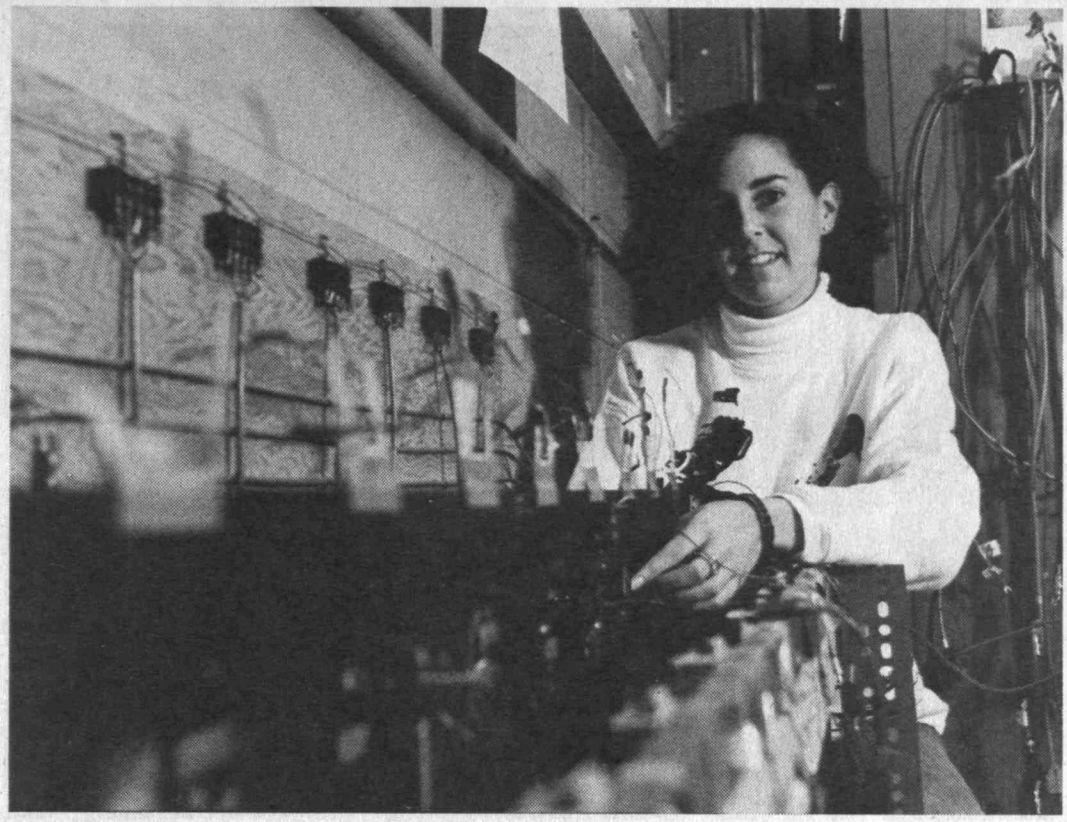
The basic idea is to create lightweight, flexible structures that can keep sensitive astronomical sensors and telescopes properly aligned. The stability of these structures will be provided by integrated control mechanisms, rather than sheer bulk. One approach is to use a precise input of electronic signals to offset vibrations that would otherwise occur.

The goal, in other words, is to build "intelligent structures with sensors and actuators built in, just like your arm," says Mar. Controlled structures technology does not mean adding "control" to "structures"; it is "a whole new way of looking at things from the start."

The field is not brand-new, Crawley says. People have been working on various aspects of it for about 10 years. "But this is an attempt to pull the pieces together."

Applications of this new technology would not be limited to space. CST could be used in the design of "precision robots," which in turn could be used for such tasks as precision manufacturing or surgery. Other applications might include prosthetics (the production of artificial limbs with built-in controls) and precision optics, such as an autofocusing camera with a deformable lens.

In fact, MIT engineers have already participated in a major earth-based project, the design of the world's largest telescope, the 10-meter Keck telescope, which is being built atop Mauna Kea in Hawaii. The primary mirror is broken up into 36 hexagonal segments; computer-controlled motors will hold the mirrors to within a mil-



Farla Fleming, '88, is one of the SERC graduate students whose training has incorporated the insights of both engineers and scientists.

lionth of an inch of their proper position. And this, according to Crawley, is just a "rudimentary form of CST."

A big part of SERC's mission is education: "We want to produce experts in controlled structures technology," says David Miller, '82, a research associate at SERC. "But rather than taking a control engineer and a structural engineer and locking them together in a cage, we hope to develop a new generation of engineers trained in both."

A space mission orientation provides a focus for SERC's efforts in developing CST. It is hoped that the space link will also attract talented students and faculty, while fostering interaction between scientists and engineers. "What's attractive from the engineering point of view is the chance to pursue research in controlled structures while working on [systems] that will actually be utilized in the near future," Canizares explains.

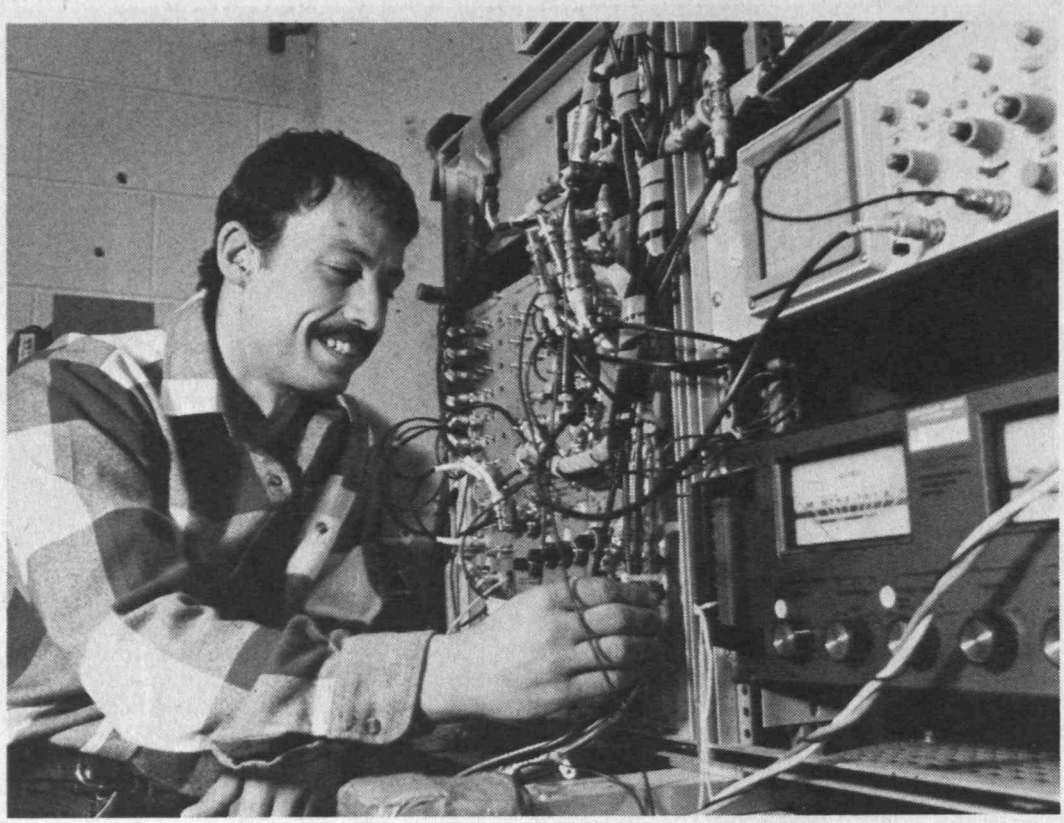
Designing structures for space poses special challenges. Vibrations, in particular, become a serious problem. "If the platform needs repositioning, if telescopes or sensors need to be pointed in the sky, you need devices for mechanical motion," Mar says. "As soon as you have motion, you get transient structural vibrations."

Vibrations subside relatively quickly when structures are anchored to the earth. Even the quivering of an airplane's wings will be minimized by the passing air, which carries off the energy of vibration—a process called "aerodynamic damping." That doesn't happen in the near-vacuum of space. "It could take an awfully long time for the vibrations to die down," Mar says. "You may not want to wait." Instead, engineers can attack the problem with control systems that feed a signal into the structure with the amplitude and frequency needed to counteract vibrations.

SERC engineers are testing the behavior of structural materials in a zero-gravity and vacuum environment at MIT's ASTROVAC (Apparatus for Structural Testing for Research on Orbital Vibration and Control). In one set of experiments, materials are launched to simulate zero-gravity during 1.5 seconds of free fall. In other experiments, materials are suspended in a vacuum and their properties are tested. Even the ASTROVAC is unable to totally isolate materials from the vibrations of the gas turbines located in the same building. So the trick is to determine what excitation is due to the material itself, and what is due to external sources.

Because of the high cost of transporting material into space, weight is another major factor in the design of space structures. "We can't afford to build something that looks like the Rock of Gibraltar," Mar says. "We prefer light, feathery structures."

An obvious goal of future astronomy missions is to see further and with greater detail than ever before. Since the resolving power of a telescope is proportional to the diameter of its mirror, the goal mandates bigger, heavier telescopes and supporting structures. But "big and heavy" means expensive, explains Physics Professor Bernard Burke, '50, a member of SERC's Science Advisory Committee. "To make these instruments feasible, we need bigger, lighter, and cheaper spacecraft."



Marthinus van Schoor, PhD '89, is studying the effects fuel sloshing around in tanks at zero gravity will have on space structures to which the tanks are attached.

CST will address the weight/cost issue directly. According to Burke, the traditional approach tended to result in structures that were more expensive, more rigid, and less representative of state-of-the-art technology. If engineers just stick to predetermined design requirements, they are more likely to use standard techniques that are not the best they are aware of.

Space missions of the future require more than just a straightforward extension of available technology. "We need innovation to jump onto a new cost curve—something that happens in the computer industry all the time," Burke says. "You can't do that by working around the edges of old technology." Such breakthroughs require a two-way flow of ideas.

David Miller agrees: "The requirements on these missions are so stringent that the traditional design process becomes unworkable. The scientists may come up with some preconceived geometry that may not be feasible. And the engineers need to know which trade-offs are possible [if they can't build the thing exactly as specified.] It's better if they're working together in the conceptual stage."

Collaboration, unfortunately, has been the exception rather than the rule. "More often than not, walls are built between scientists and engineers," Burke says. "This 'us versus them' attitude is bad for science."

Both Kerrebrock and Burke pointed to the Hubble Space Telescope as an example of a project that suffered from the lack of creative input from engineers. Owing to technical difficulties, the telescope—scheduled to be launched in December, 1989—has a smaller mirror than originally planned. Even with the mirror scaled down from 3 meters to 2.4 meters, scientists had difficulty achieving the desired precision.

Joining forces from the start of a project may help scientists and engineers do more than meet their objectives—it may help them redefine their goals, Kerrebrock believes. "Through such collaboration, there is the possibility that one would decide to undertake missions that didn't seem feasible on the basis of existing technology," he says. "Scientists could become aware of engineering capabilities they wouldn't have [known of] otherwise, in the same way that research engineers become aware of new objectives."

The proposed space-based optical interferometer is an example of a system that would be prohibitively expensive without innovative engineering. Interferometry employs widely separated telescopes to achieve the resolution of a mirror as large as the distance between them. A facility like this would be able to see details of stars, which appear only as points of light on current telescopes. The search for planets is another potential application.

"We've never positively identified a planet around any star other than the sun," Canizares says. "Most people assume planetary systems are common, but we'd like to know for sure."

An even more exotic example would be a gravity wave detector in space. Such a device would look for local distortions in space caused by a passing gravity wave. Einstein predicted the existence of these waves early in the century, but none have ever been detected by earth-bound devices. "Right now, it's hard enough to do this from the ground," Canizares says. "But in the next century, it's very likely that we'll put a detector up in space, and we'll need advanced controlled space structures to do so." □

UNDER THE DOMES

Interphase Touches Its Roots

By David Hamilton, '89

In 1968, minority students composed a tiny fraction—three to six students—of each incoming class.

"When I came to MIT, I was the only black woman in many of my classes," says Shirley Jackson, '68, the first black woman to receive a doctorate from MIT. "I worked alone; I ate alone. Don't get me wrong—I did very well at MIT. But I didn't like it. I had no community here."

But Jackson played an important role in changing all that. When she and other founding members of the Black Students Union presented the MIT administration with a list of grievances and recommendations, the results were little less than remarkable. MIT created, then heeded, the suggestions of a Task Force on Educational Opportunity. In just over a year, there was a nearly tenfold increase in minority enrollment.

(At MIT, underrepresented minorities include black, Native American, Puerto Rican, and Mexican American students.)

Some of the reforms ushered in by the task force have fallen by the wayside or failed to achieve their goals, but at least one program is an ongoing success. Project Interphase, a summer program designed to acclimate disadvantaged students to the rigors of the Institute, marked its 20th anniversary in April with an event that was both a celebration and a critical self-evaluation of the program's methods and goals.

Open to newly admitted minority students by invitation only, the eight-week program aims to provide both academic and social preparation for MIT. It is, according to Albert Hill, professor emeritus of physics and chairman of the Task Force on Educational Opportunity, "an attempt to let the clutch out slowly over the summer, rather than with a bang in September."

The demanding academic schedule includes mathematics, physics, and writing classes for which participants receive up to 18 units of credit. On the social side, activities such as hiking excursions to Mount Monadnock in New Hampshire or day trips into Boston are common. Students participate in seminars emphasizing study skills and time management, and meet with administrators, guest alumni and alumnae, and members of MIT support services.

The Interphase veterans attending the anniversary generally agreed on the importance of the program and the increased self-confidence it gave them. Karl Reid, '84, remembered an "exhilarating sense of accomplishment" at solving challenging problems. Others, such as Richard Williamson, '85, spoke of the closeness they found in the tightly knit Interphase community. "These people became part of my life," Williamson said.

On the other hand, some felt that they paid a high price for the communal feeling. Beverly Herbert, '75, said that the Interphase academics were "rougher than any regular MIT class," and that the session felt "like boot camp—we were just thrust into this position and had to survive."

The "boot camp" atmosphere is something that the program's current director, Anthony Canchola-Flores, says he hopes he's eliminated. "It used to be strict here—really strict," he recalls. We try to treat people more like entering college students now."

Interphase has a history of annual modification, but an experimental proposal for the coming year may represent the most dramatic changes to date. The changes are in response to persistent concerns: Although 85 percent of all non-minority students admitted to MIT go on to graduate, only 70 percent of minority students do so; minorities have consistently lower grade-point averages than their non-minority colleagues; and a disproportionate number of minority students receive academic warnings or requests to withdraw from the Institute. To confront those issues, Dean

Member of the MIT Corporation Shirley Jackson, '68, led a discussion of the stigma that is sometimes attached to special programs like Interphase.

PHOTOS: KYLE G. PELTONEN, '89

for Student Affairs Shirley M. McBay suggests linking Interphase with the first term of the freshman year.

McBay's plan calls for Interphase students to work in small study groups that would be required to meet for eight hours per week, starting during the summer and continuing for the entire first term. Studying together would require that students enroll in the same core subjects: calculus I (18.01), physics I (8.01), a non-writing humanities subject, and a seminar. Upon successful completion of the first term, these students would receive the typical 54 credits—less than they would have accumulated when 18 hours of credit was awarded for Interphase alone.

At the Interphase anniversary, the dean's proposal came under sharp attack before she had even finished presenting it. Many participants expressed fear that linking Interphase with the regular academic year could lead to "ghettoization" of minority participants. One man told her that "a summer program is fine; but there's a problem if this gets extended through all four years." Darian Hendricks, '89, went a step further, suggesting that as Dean of Student Affairs, McBay was addressing the concerns of the Institute as a whole and neglecting the special needs of the minority community.

The response to the proposal was so heated that at one point McBay raised her hands in frustration and said, "I need to make this clear: this is an experiment."

Despite the evident success of Interphase—60 percent of the program's alumni are in graduate school or have advanced degrees—many of the audience members at the anniversary expressed a certain unease with its status as a "special program." In a free-wheeling discussion led by Shirley Jackson, the audience considered the "stigma" of participating in special programs, whether participants are relegated to a minority subculture at MIT, and whether a program like Interphase "lets faculty off the hook" by relieving them of responsibility for meeting the special needs of minority students.

Some of those concerns about stigmatization took an unusual twist. Abdon Ruiz, '88, who arrived at MIT with a strong academic background, said he found his invitation to participate in Interphase almost a stigma in itself, because it implied that "something was wrong with me." Some who were not invited felt unfairly left out, particularly one woman whose self-described "fear of calculus" led her to envy the head start offered to Interphase.

All minority students are now invited to apply to Interphase. In recent years, there have been more applicants than there are places in the program, so a committee made up of faculty and Admissions Office representatives decides which applicants are most likely to benefit from the program. (In a later interview, Canchola-Flores noted that a number of minority students are able to participate in Upward Bound or other enrichment programs closer to home.)

No matter how many turns the conversation took, however, one point kept resurfacing. As James Bishop, PhD '69, the first director of Project Interphase, put it, "We will always have a problem until we have proper representation at all levels—faculty and administration." There are currently only 25 minority (combined black and Hispanic) faculty members at MIT, a decline from the peak of 32 minority professors in 1980. "If we learn nothing else from this conference, it is this," Bishop said. "We need to change the numbers." □

Top: Interphase's first director, James Bishop, PhD '69, is now special assistant to the provost for academic affairs at Ohio State University. Bottom: Dean for Student Affairs Shirley McBay presented a controversial proposal for the future of Interphase.

DAVID HAMILTON, '89, is completing a five-year program leading to a bachelor's and master's degree in electrical engineering and computer science and is a writing intern at Technology Review.

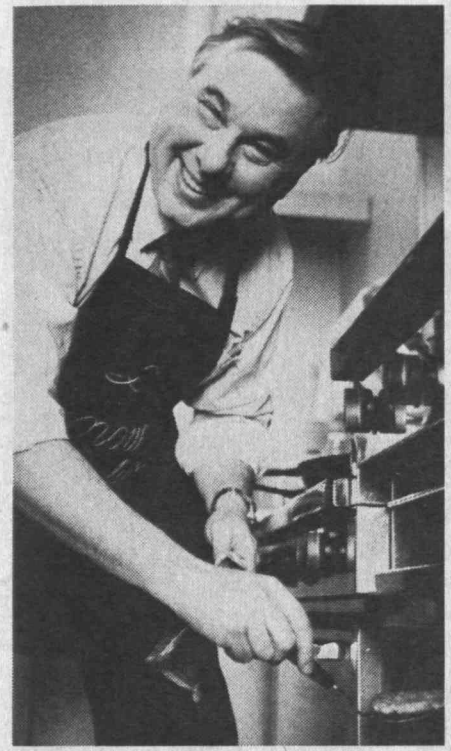
Bush Picks Schmalensee

An MIT professor and registered Democrat from Brookline has been selected by George Bush to be one of three members of the President's Council of Economic Advisers. But it's not so surprising, says Richard L. Schmalensee, '65. "I have been accused of a lot of things, but being an ideologue is not one of them."

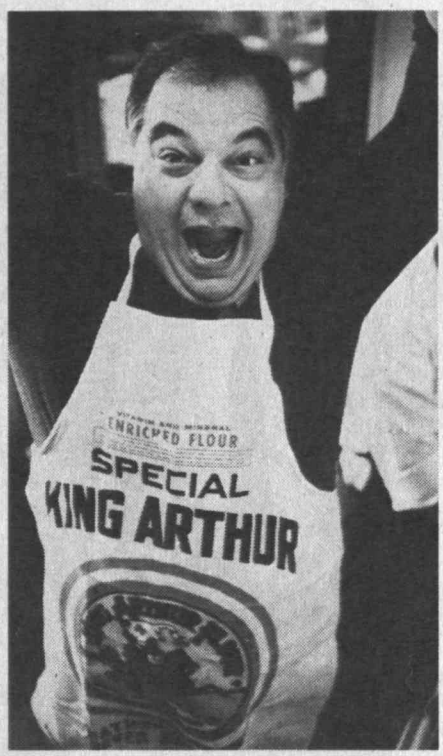
While he was earning a PhD in economics at MIT, Schmalensee spent the summer of 1967 as a junior economist on the staff of the Council—and that had been his only full-time government experience to date. From 1972 to 1981, he served as a consultant to the Federal Trade Commission's Bureau of Economics. According to the *Boston Globe,* he has not been active in politics, and has no close relationship with anyone in the Bush administration. Pending Senate confirmation, Schmalensee and Stanford Professor John Taylor are expected to join Michael Boskin, another Stanford economist who is already confirmed as council chairman.

Lawrence Summers, a Harvard economics professor and a top adviser to the Dukakis presidential campaign, was quoted as saying: "This group is as well respected as any that we have seen in recent years. They are people whose advice any administration would profit from."

The *New York Times* described the three Council appointees as "career academics known for their moderate political views and an eclectic approach to economic theory." Schmalensee told the *Times* that his "in-



Gerry Wilson



Jay Keyser

Renowned* latke *maker and Dean of Engineering Gerald Wilson, '61, said he hated to peel potatoes. Associate Provost Samuel J. Keyser scoffed that it didn't take all that long. A bet ensued. Could Keyser peel 10 pounds in half an hour? Wilson wagered not—but Keyser delivered the skinned spuds in 16:17.00, with the test tubers ending up as* latkes *(or potato pancakes) cooked by the duo. While Wilson now owes Keyser dinner at a Chinese restaurant, he did get in the last word. Said the dean about the associate provost: "Of course, he's a braggert and a showoff and that's why he brought a photographer with him."

teret is regulation, broadly defined to include issues like antitrust." He speculated that he would be involved in regulatory issues in such industries as telecommunications, airlines, and financial services, and said that he travels a middle, "realistic" road in assuming that neither regulation nor markets work perfectly. "You have to make a choice among real possibilities," he said.

Under President Reagan, the Council of Economic Advisers was allowed relatively little influence, and at one point Reagan considered abolishing it. Bush's choice of three moderate pragmatists to advise him would seem to indicate a desire to take the Council seriously.

Schmalensee is the Gordon Y Billard Professor of Management and Economics, a chair most recently held by Dean of Management Lester Thurow. After earning his doctorate in 1970, he became an assistant professor at the University of California, San Diego, and rose to associate professor before returning to MIT in 1977 as an associate professor of management. In 1979 he was made a full professor, and since 1986 has held a joint faculty appointment in the Department of Economics.

He has been a visiting professor at Harvard College, Harvard Business School, and the University of Louvain in Belgium. He is on the editorial board of several professional journals, and has published widely, most recently as coauthor, with MIT Professors Stanley Fisher and Rudiger Dornbusch, of the second edition of the textbook *Economics*. Schmalensee came to national prominence in 1977, when the FTC presented his studies of the breakfast cereal industry in a suit that charged the three leading cereal makers with controlling the industry. □

LEGO My Logo!

The link between the Logo programming language and LEGO bricks, which has been building for five years now, has been cast in a lasting form: the LEGO Professorship of Learning Research in the MIT Media Laboratory, to be held by Logo developer Seymour A. Papert and endowed by the LEGO Corp. of Denmark. Papert has been associated with MIT since 1963 and is a former Cecil and Ida Green Professor of Education. He has been collaborating with the LEGO Group since 1984 to devise a system called LEGO TC Logo, which allows children to write computer programs to control machines they build using LEGO parts.

While the children are playing, says Papert, they are also learning about mathematics, science, and design. "When children build things they care about, they learn that learning can be exciting." He envisions a school of the future that places new emphasis on child-based invention rather than rote learning. Both Papert and LEGO see learning "as a constructive process in which children learn new ideas through active exploration and experimentation."

The new chair was announced by MIT and LEGO Systems of Enfield, Conn. Almost two billion LEGO bricks and DUPLO blocks are manufactured each year in the United States. □

PHOTOS: DONNA COVENEY

Dean of Science Gene Brown (right) presented this year's Science Council Teaching Prize to Professors Anthony P. French of physics (left) and Arthur P. Mattuck of mathematics (center).

Freshman SAT Scores Rise

Fifty-one percent of the students offered admission to MIT next fall scored between 750 and 800 on their math SAT scores, according to Director of Admissions Michael Behnke. In 1988, only 41 percent of those admitted scored in that range. The mean SAT math score increased from 727 to 741, and the mean verbal score from 636 to 640. Mean achievement scores in science, math, and English/history showed similar increases.

Behnke attributed the score increases to several measures taken by the admissions office to address "the concern of some faculty about what they perceive as a decline in the number of students with top motivation and ability in math and science." A newly redesigned academic rating to assess applicants, greater involvement of faculty in evaluating admissions applications, and the participation of eight science and engineering professors in the final admissions decisions all contributed to the strong SAT scores in the new class.

The number of applicants this year declined by 10 percent from last year, but more students were accepted in order to increase the class size from 1000 to 1050. The percentage of students ranked first in their high school class remained at 39 percent, while those in the top 5 percent increased from 88 to 89 percent. Women continue to make up 35 percent of those admitted, and although the percentage of underrepre-sented minorities declined from 16 percent to 13 percent, the actual number is the second highest in MIT history, noted Behnke. □

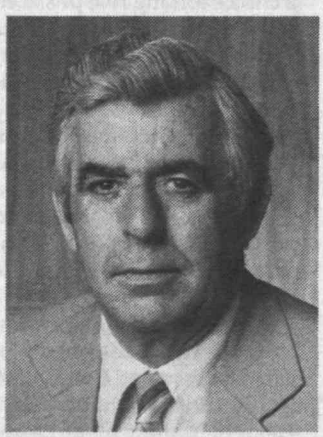
UAW Leader Named Lecturer

Don Ephlin, international vice-president of the United Auto Workers and director of the UAW's 400,000-member General Motors Department, will become a senior lecturer at MIT in the fall.

He will be affiliated with the Schools of Management and Engineering and with their Leaders for Manufacturing Program. That program, established in 1988, links the two schools with 11 of the nation's major manufacturing corporations in an effort to recapture world leadership in manufacturing.

Recognized as one of the country's most innovative labor leaders, Mr. Ephlin pioneered development of union programs to gain greater job security and to democratize the workplace by increasing employee involvement and improving the quality of worklife.

In 1982, he led the UAW's negotiations at Ford. The results are generally credited with preventing Ford's financial collapse and enabling the



Don Ephlin

PHOTO: DONNA COVENEY

company to return to profitability.

At GM he led the negotiations and joint consultation processes that produced the Saturn and NUMMI agreements. He also cochairs GM's Quality Network, a corporate-wide effort to improve quality through innovations in manufacturing and human resource management.

"Unions are key to manufacturing in the United States. Ephlin will bring the perspective of an experienced labor leader who has been heavily involved in important developments in that arena," Professor Robert McKersie of Sloan's Industrial Relations Section said. Ephlin has been an active supporter of MIT research on innovations in industrial relations.—*Paula Cronin, from* Tech Talk. □

Edgerton Award to Tsitsiklis

Associate Professor of Electrical Engineering John N. Tsitsiklis, '80, has been chosen to receive this year's Edgerton Award, presented to an outstanding junior faculty member in recognition of exceptional distinction in teaching, research, and scholarship. The award, named in honor of Institute Professor Emeritus Harold E. (Doc) Edgerton, carries a $5,000 cash prize.

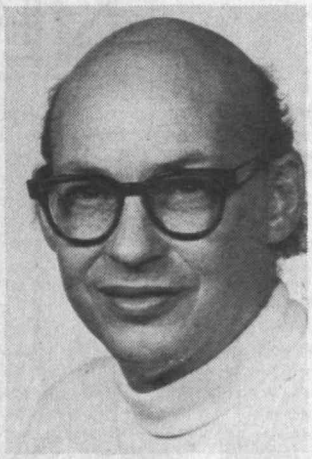
Tsitsiklis' field is complex distributed systems. He has been seeking mathematical techniques useful in describing, analyzing, and handling their complexity, as well as methods for organizing communication among components of such systems. He was responsible for the seminar at MIT on parallel and distributed computation, from which sprang 6.255, Computation and Communication in Distributed Systems, and is also in charge of reorganizing 6.251, Introduction to Mathematical Programming. He and Dimitri Bertsekas, PhD '71, are the coauthors of *Parallel and Distributed Computation: Numerical Methods.*

John Tsitsiklis

Born in Greece, Tsitsiklis received two bachelor's degrees from MIT in 1980, in EECS and mathematics, and subsequently a master's and PhD in Course VI. In 1986, he was named a National Science Foundation Presidential Young Investigator. □

Minsky to Give Killian Lectures

Donner Professor of Science Marvin L. Minsky has been named the 1989-90 Killian Award Lecturer. The James R. Killian, Jr. Faculty Achievement Award, established in 1971 as a tribute to the late MIT president, is the highest honor the MIT faculty bestows on one of its members. The award carries an $8,000 honorarium and its recipient usually delivers two lectures in the spring term of the award year.



Marvin Minsky

Minsky's citation described him as "one of the founding fathers of artificial intelligence" and said that he has "exerted a marked influence on the field ever since. Sometimes a gadfly, he has produced a stream of provocative and controversial ideas which have shaped the identity and development of the field."

The citation went on to trace his early career: "Marvin received a very broad education as an undergraduate at Harvard. When he graduated in 1950 he had studied, in some depth, physics, biology, music, psychology, and mathematics. He had also begun to think about building an electronic machine that would learn.

"While a graduate student at Princeton, which led to a thesis about how a neural network might learn, he returned periodically to Harvard to design and build an electronic learning machine with 300 vacuum tubes and numerous motors and clutches. After receiving his PhD from Princeton in 1954, Dr. Minsky came back to Harvard for three years as a Junior Fellow. During this period he invented and patented the confocal scanning microscope. It was also during this period that the first conference on artificial intelligence was held at Dartmouth College in 1956. The following year Marvin moved to MIT's Lincoln Laboratory and then a year later he was appointed to the MIT faculty as assistant professor of mathematics."

In 1959 Minsky initiated the MIT Artificial Intelligence Project with John McCarthy, and 10 years later the Artificial Intelligence Labororatory directed by Seymour A. Papert and Minsky, remaining director until 1973. He has been Donner Professor since 1974.

As one of the most influential leaders in the field of artificial intelligence, Minsky has emphasized approaches to problems of symbolic description, knowledge representation, semantics, machine perception and learning, and both psychological and physiological theories of imagery, memory, and new computational structure.

As a mathematician, he also has been a strong influence in leading the computer science community away from the limitations of finite-state and recursive-function formulations into the present era of algorithmic complexity and related theories. His work with Dr. Papert on the theory of computational geometry and "Perceptron" machines is considered a classic in this area, as is his earlier work on Turing machines and production systems. □

ALUM· NEWS

Shaping Up the Organization

Just about a year ago, the officers of the Association of Alumni and Alumnae of MIT reorganized the association's professional staff to provide more effective and responsive support to volunteers.

Where once there were separate units with separate reporting structures, now there is one unit serving both alumni activities and fundraising. Joseph S. Collins, formerly director of only the Alumni Fund, heads the combined unit and holds the title of managing director, Alumni Activities and director of the Alumni Fund.

Reporting to Collins are five units whose staffs are delineated by the constituency they serve and the type of service they support:

■ Diana Strange is the director of one of the largest units: Classes and Events Programs. Her staff members work in three areas: Class Programs and Affinity Groups (such as BAMIT and AMITA); Major Reunion Giving—backing up the reunion gift committees of the 25th, 40th, and 50th reunion classes; and Reunions and Events—helping to organize all the quinquennial reunions, the National Alumni Conference, Technology Day, and other special events.

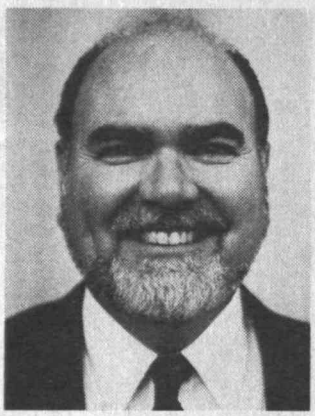
■ Mary Norman, director of the Alumni Fund Visit Program, oversees three area directors who work with teams of alumni/ae volunteers who in turn undertake to meet personally with established donors and encourage them to increase their support.

■ Joseph Recchio heads what's called the Three-Ds unit—direct mail, donor recognition, and data base. "Direct mail" means the letters and other communictions that encourage alumni/ae to support special needs at MIT. "Donor recognition" means saying "thank you for your gift." Both functions depend heavily on the association's computerized data base.

■ Jeffrey Solof, '81, heads Graduate Alumni, Parents, Students, and Young Alumni Programs. His group works on such projects as newsletters from the academic departments to their graduates, dinners for students about to receive degrees, student-staffed telethons, and MIT Family Weekend.

■ Janet Serman is the director of Regional Programs. The five regional directors reporting to Serman work with MIT clubs coast to coast to help their members stay connected to MIT.

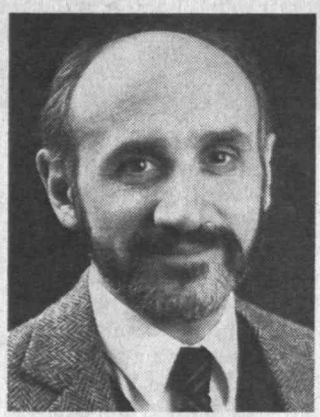
With a unified reporting structure, there are now lines of communication among staff and volunteers where once there were roadblocks. No longer are the reunion gift chair and the reunion chair, for example, operating on separate planes. The hope is that things are going so smoothly, alumni/ae hardly notice who's doing what. □



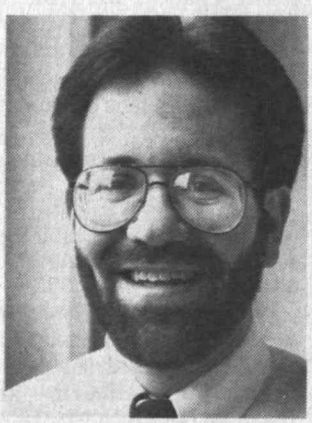
Joseph Collins

Diana Strange

Mary Norman



Joseph Recchio



Jeffrey Solof

Janet Serman

PHOTOS: BARRY HETHERINGTON, KINDRA CLINEFF

CLASS NOTES

18

I am grateful to faithful **Herb Larner,** who sent me copies of articles in which he has a particular interest. One is on foreign affairs by Richard Nixon, and the second concerns itself with Black Tyranny in Africa.—**Max Seltzer,** Secretary, 865 Central Ave., Needham, MA 02192; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

We received a letter from **Allen McIntosh** announcing his plan to attend our 70th reunion. He will be accompanied by his son or daughter-in-law. Good for you, Allen! We shall be pleased to be with you again. So now we have a total of eight classmates.

We regret to report the passing of **Russell S. Palmer** on December 23, 1988, after a long illness. After graduating, he enlisted in the Navy Medical Corps. Later he went to work for the Sperry Gyroscope on Long Island, and remained with them until his retirement in 1973. He was a life member of the Appalachian Club and a member of the Sperry Flying Club. He attended our 65th reunion. We shall miss him. He is survived by his sister Mrs. Charles N. Borden of Chestnut Hill, Mass.

I would be pleased to hear from you.—**W. O. Langille,** Secretary, P.O. Box 144, Gladstone, NJ 07934

21

The only news I have this month is the death of Elizabeth T. Barriger, widow of **John W. Barriger III.** John and Elizabeth came to a number of our reunions. John entertained by reminiscing about his experiences as president of various railroads. My friendship with John goes back to undergraduate days at MIT where John, **Jack Rule,** and I lived on the sixth floor of Runkle Hall, climbing five flights of stairs several times a day. They were good days! Elizabeth is survived by John W. Barriger IV, '49. Our sympathy goes out to him.—**Summer Hayward,** Secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

Martha Eiseman Munzer is the subject of the feature article in the City Plus section of the *Fort Lauderdale Sun Sentinel* of Sunday, February 12. Her picture, in color, takes up the entire first page, followed by a long biographical account accompanied by another half-page photograph. Martha is currently engaged in writing a book about the history of Lauderdale-by-the-Sea, which she hopes to finish by the end of the year. Considering all her past accomplishments, Martha must rank as one of the most outstanding members of 1922. Our renewed compliments to her.

Since writing about the death of George Holderness in the February/March notes, I have learned that he is survived by his wife, Mildred, who lives at 145 Midland Ave., Bronxville, N.Y. . . . Your class president and secretary have conferred several times in recent months by phone and mail, finding each other in relatively good shape but failing to devise a method of extracting information from or about the other 160 of you. . . . For the secretary's part, he and wife Ruth went to Bermuda for the umpteenth time in January, finding it far less attractive than their first visit there in 1952. Crowded, noisy, prices way up, and 525 taxis in 21 square miles.

Back to the first person—by the time you read this, I hope I will have seen some 22ers at Technology Day. In connection with Alumni Day at Andover, which I regularly attend, I am reminded that our classmate, **William C. (Bill) Gray,** who died unexpectedly from a fall two years ago, left a substantial bequest to Andover. This should be a reminder that we can't take it with us. Review of wills might be well worth considering.—**Yardley Chittick,** Secretary, Rte. 1, Box 390, Ossipee, NH 03864

23

The first day of spring so now 85 degrees fahrenheit. Eat your heart out down there in Florida. Maybe your secretary is jealous, but we have had a fantastic winter with little snow and rain although we need rain badly.

My mention in the last *Review* of the surveying course in East Machias, Maine, and wondering how many might be alive now who were there in the summer of 1921, prompted a telephone call from Horatio Bond, who lives in Hyannis Port, Mass. The camp was used for field training for civil, sanitary, mining course engineers and a sprinkling of others. We both agreed it was a highlight of our Tech education. We reminisced for quite a long time. Surely there are many others in our class who were there. Let's hear from you.

With the paucity of news from our class, president **Royal Sterling** makes a plea in a "Call for Papers" from our class. I quote: "The Great Class of 1923 is withering on the vine. We must all do something to rejuvenate it. At our 65th, after many years of devoted and hard work, **Dick Frazier** resigned as secretary-treasurer. **Fred Almquist** was asked to take the job. It is difficult for him to find material for each copy of the *Review* to make interesting reading. Therefore I am speaking to all you classmates to help out by sending him a letter recounting something of interest that happened before or after graduation. If enough of you do this, Fred will be supplied with material for a long time." The President has spoken.

Reports of three of our classmates having passed away have come in since the last *Review.* **Lawrence G. Petersen,** '36, reports that in his scanning of the newspapers in the vicinity of Schenectady, N.Y., he found that **Neal L. Parker,** a GE retiree, died on January 10, 1989. Neal graduated with our class having prepared earlier at the Lyndon Institute in Lydonville, Vt. An employee of General Electric Co. for 45 years, he retired as manager of the industrial sales and engineering division. He was a member of the GE Quarter Century Club, Elfon Society, the Lower Mohawk Club, the Zion Lutheran Church, the Bethlehem Lodge of Free and Accepted Masons, and other organizations. Survivors include his wife, a daughter, a sister, a granddaughter and a great-granddaughter.

Frank Perkins Knight, Jr., died September 27, 1988. Born in Manchester, Mass., he came to MIT following a year at Cornell University. He earned his SB degree as a member of our class in mining metallurgy. His activities were many while an undergraduate. He married Laurestein Foster of Norway, Maine, and they had three children. After graduation and until 1934, Frank was manager and director in the non-metallic mining industry. From 1935 to 1957 he was mining engineer, manager, officer and part owner of small copper-producing companies. He was very active in mining activities and was a Fellow, American Ceramic Society, member of AIME, and Legion of Honor, AIMM&P.

The death of another GE retiree has recently come to light. **Abraham Cohn** died on September 29, 1988. He was a patent attorney for GE, Schenectady, N.Y. He received a bachelor's degree in chemical engineering following which he graduated from the National University Law School in Washington, D.C., in 1927. Following graduation he worked for the U.S. Patent Office in Washington, D.C., from 1925 to 1928. In 1929 he joined GE as patent attorney and legal counsel. He retired in 1965. Abraham was a member of Washington, D.C., and Massachusetts Bar Associations. He married Ethel Auspitz, a native of Hungary. They have three children and seven grandchildren. God Bless!—**Frederick O.A. Almquist,** Secretary/Treasurer, 63 Wells Farm Dr., Wethersfield, CT 06109

24

Until we find a class secretary, the *Review* will report on any news sent to our offices. This month we have a few items of news and many obituaries. Please send in news about yourself so we can improve the balance. **John B. Lewis,** of Hightstown, N.J., writes that he moved to a retirement home a year ago. He received his BS from Princeton in 1922 and was president of that class so he visits there a lot when not traveling to visit his son in Brazil and daughter in Honolulu. . . . We have deciphered the name of our correspondent in Carefree, Ariz., to be **Austin G. Cooley.** Austin tries to "keep up with the world by way of ham radio." . . . **Rutilio Torres G. Saravia** wrote to Russ Ambach in December, 1988, about his life in Guadalajara, Mexico. He lives alone at his home of 57 years, since his wife's death last July. His nine children live independently "some of them with descendents

and others divorced, so I live in my house all by myself; cleaning, cooking, and doing all kinds of house work, but happy to live and ready to pass away when the Almighty decides to do it. Our economic troubles are still the same: 2,350 pesos for a U.S. dollar, and a huge foreign debt; but I always think for the best."

Edward A. Saibel, died on April 9, 1989, in Durham, North Carolina, after a lengthy illnesss and an outstanding career in teaching, mathematics, and mechanical engineering. Last winter, honorary membership was conferred on him at the annual meeting of the American Society of Mechanical Engineers. He was cited for "60 years of outstanding, innovative contributions to engineering education and applied mechanics research and for his dedication to basic research and technical leadership."

Saibel had moved to Durham in 1972 and was a senior scientist at the U.S. Army Research Office and an adjunct professor at Duke University and North Carolina State until his retirement in 1986. Previously he had taught at the University of Minnesota, Carnegie Institute of Technology, Rensselaer Polytechnic Institute, and was an Institute Professor at Carnegie Mellon University. He was a member of the America Mathematical Society, the Mathematical Association of America, and the British Society of Rheology. He was a fellow of the American Society of Mechanical Engineers, a fellow of the American Lubrication Society, and fellow and past president of the Society of Engineering Sciences. He authored 140 scientific papers and was the recipient of the national ASLE Award for 1972, the Mayo Hersey Award for 1978, and the National Award of the American Academy of Mechanics for 1985. Edward Saibel is survived by his wife, Lillian, a son, daughter, five grandchildren, and three great-grandchildren.

Leigh Fogg passed away on October 21, 1988, at age 86. His neighbor in Gorham, N.H., had been tending to his mail and wrote, remembering Leigh as "a brilliant man and an exceptional neighbor. We miss him very much." . . .**Paul L. Miller,** of Silver Spring, Md., died October 16, 1988, while hospitalized for a urinary tract and blood infection. . . . **Dorothy Ward Hanley** died December 29, 1988, of heart disease at the age of 91 in her home in Hampton, Pa. Dolly Hanley was a social and civic leader and widow of Allegheny Ludlum Steel Corp. chairman and president Edward J. Hanley. She was an internationally known hostess having given a reception and dinner that was attended by the king of Belgium and other prominent European figures at the opening of an Allegheny subidiary in Belgium. She was a founding member of the Duquesne University Women's Advisory Board. She is survived by her brother.

Rudolph A. Schatzel, of High Point, N.C., died October 19, 1988; **Jay F. Buswell,** of Clearwater, Fla., died July 9, 1987; **Arthur J. Kemp,** of New Canaan, Conn., died December 17, 1987; and **Tien A. Koe,** of Honolulu, Hawaii, died March 23, 1988. We have no other information about these classmates.

Please send in your news through the Alumni Fund or directly to the *Review* office.— *ed.*

25

The New York Society for Coatings Technology at a meeting last December honored **Temple Patton,** scientist and author, for his many contributions to the coatings industry. The society presented a scholarship to a senior attending Fairleigh Dickinson University in honor of Temple. Of the three technical books prepared by Temple, one edition appeared as a Japanese translation, and another appeared as a pirated Russian translation.

Milt Salzman writes to remind us that he is still alive and active with a barbershop chorus, church choir, and home chores. A few months ago he celebrated his 85th birthday at an outdoor party with his son (MIT 1955) who has recently returned from a four-year stint in Europe.

"It was done in a playful mood," says Professor Emeritus-Artist C. Fayette Taylor, '29 (above left). His sculpture, "Terra Cognita" represents "the world we know—the world with all its beauty and problems." The sculpture of welded steel and gold leaf was donated to Northeastern University last March. The University's president, Kenneth G. Ryder, assisted in the unveiling.

It is with sorrow that the passing of **Roland Seabury** must be reported. He died on January 13, 1989, at his home in North Weymouth, Mass., where he had lived his entire life. He was a retired salesman for Chushman and Mardin of Boston, a shoe findings company, formally a family business. Roland was a World War II army veteran where he attained the rank of major. He was a member of the Orphan's Hope Masonic Lodge and the board of the North Weymouth Cemetery Association. He was a member, past moderator, and deacon of the Pilgrim Congregational Church. Roland is survived by his wife Grace Evelyn (Dunham) Seabury, a son, and a daughter.—**F. Leroy (Doc) Foster,** Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

There is good news to report. **Ralph E. Colclesser** has not left us, as was published in the February class notes, but is "very much alive and happily retired in Stuart, Fla." I certainly am sorry that we reported the bad news but am glad to pass on the good news. We wish many others who have been reported deceased were still with us.

In February I attended a luncheon of the MIT Club of Cape Cod and Hyannis. They had an interesting meeting on the "Solar Powered Car." The power is developed by the sun charging a battery, and this operates an electric motor. The speaker, who is a senior, had raced the car in Switzerland, Australia, and the United States. He wants to form a company when he graduates in June to manufacture them, primarily as a commuting car. . . . **Morris L. Minsk** calls me from time to time. I'm sure he would like to hear from you, (617) 884-3036. Give him a ring.

We learned from **Bill Meehan** that **Alden W. Peterson** of Sturgis, Mich., died July 14, 1988. Alden had three sons and 10 grandchildren. He had a very interesting career with patents and a consulting business that he conducted until 1983. His hobbies were photography and travel. . . . **Henry C. Rickard** and his wife, Frances, were pictured in the April 1989 *Technology Review* for "Donor's Profile for the MIT Life Income Funds." You may want to check on the funds.

I hope many of you are having an interesting life. Let me hear from you. We have just returned from a cruise of the Grenadines and Orinoco River in Venezuela. We went up the river 180 miles. It still was from one to two miles wide at Ciudad Guayana.—**Donald Cunningham,** Secretary, 27 Lowell St., Braintree, MA 02184

27

Have received a kind letter from **Andrew Anderson** from his home in Pompano Beach, Fla., where he and wife Ann have retired since 1968. An electrical engineering graduate, he has spent his career in manufacturing with electrical product companies. He was plant manager and vice-president of Schick, Inc., then became general manager of Special Products, a division of Thomas A. Edison Co., where he received the Naval Ordnance Development Award. Having started with Monroe Calculating Machine Co. in 1927, Andy became manufacturing vice-president and director and was appointed plant manager of their Bristol, Vir., plant in 1960.

Andy refers to the death of his friend and classmate **Arthur J. Buckley** on December 7, 1988, in Hagerstown, Md. Both were members of the Orchestra and Banjo Clubs at MIT, where many of us shared good times at concerts and dances at girls colleges. Also an electrical engineer, Art started work with Edison Electric Labs., then transferred to Spray Engineering in Boston. From 1942-1952, he was with P & H Harnishfeger in Milwaukee and became assistant export sales manager and sales manager of the Eastern Divi-

PHOTO: RUSS SPARKMAN

sion, headquartered in New York City. He sold cranes and hoists throughout South and Central America. He also was in charge of their Prefabricated Housing Division in New York.

In 1952, Art joined with the Pangborn Corp. and, after 16 years of service, retired in 1968 as vice-president of foreign sales in Hagerstown, Md. Then for 10 years, he was a substitute teacher in the Washington County School in math and science classes. He is survived by his wife, Gladys; daughter, Barbara Downey; and son, A. Jay Jr., to whom we send our sympathy.

I must tell you of the great experience your secretary has enjoyed recently. Together with William Siebert, professor of electrical engineering at MIT, wife, Sandy, and four other sailing friends, we chartered a 46-foot ketch in Phillipsburg, St. Maarten. We were in the center of a group of the Leeward Islands covering a distance of only 40 miles: from Dog Island in the northwest to Prickly Pear Cay (British) to Anguilla (British) to St. Maarten (French and Dutch) and St. Barthelemy (French) in the southwest. These old volcanic mountainous islands provide numerous bays, coves, and unspoiled sandy beaches for comfortable anchorages protected from the steady east north east tradewinds. Chart A24 from *IMRAY-Iolaire* presents the whole picture with nine enlarged details of anchorages on the border of the chart. The little French town of Gustavia, with a fine protected harbor, is a good example of easygoing French living. Such an experience is good for the soul of old-time sailors with the good fortune to have friends with strong arms to man the jib winches and, for a brief period, to join in the thrill of modern yachting life.—**Joseph C. Burley,** Secretary, RFD Box 416, Epping, NH 03042; **Lawrence B. Grew,** Assistant Secretary, 21 Yowago Ave., Branford, CT 06405

28

Oops! In our last issue of these Notes we reported erroneously that **George Palo** had been elected treasurer of his condomium association. That honor correctly belongs to **Claude Rice** and not to George (who continues comfortably in his own home). So, our congratulations to Claude and apologies to both gentlemen!

At the beginning of this year, we made an effort to reach everyone in the class with a greeting. We have had a good number of gracious replies, some with news, all of them most welcome. . . . We were very pleased to have a letter from **Bud Gray** but then saddened to learn that his lovely wife, Helen, had died two years previously. They had been married 56 years. Bud retired as chairman from Whirlpool Corp. in 1971. Now his efforts on much needed community rejuvenation keep him totally busy. Hopefully we will see him at our next gathering of the class. . . . **Harold Bialkowsky** writes in reminiscence of his business and social contacts with **Ralph Jope** and **Jim Donovan** many years ago. Harold now lives in the Columbia River Gorge area not far from the Vancouver military site where Jim was born. Harold has been active and prominent in the pulp and paper business all his professional life and apparently has enjoyed every bit of it.

Gertrude and **Sid Brown** tell us: "We had a busy summer (1988)—a Baltic cruise with two days in Leningrad (where the people in the streets look the same as they do in Boston), then ten days in Paris with Gertrude's art group." . . . A nice letter from **Al Gracia** says that he is well and happy. His abode is now a life-care facility which relieves him of cooking and housekeeping and so leaves more time to enjoy those things he would far rather do. Al still spends the month of February in St. Thomas, V.I., and the months of July and August in Maine. . . . We are sorry to learn that **Bill Hurst** suffered an accident last September and is only now (mid-February) starting to walk again. In spite of this misfortune, he gave two technical papers earlier in the year, one each to the American Association of Mechanical Engineers and The Society of Petroleum Engineers. These papers dealt with the finding of oil in producing and abandoned fields by reservoir simulation using computers. This is Bill's longstanding field of professional expertise.

We have had the pleasure of receiving an unusual number of notes and letters from '28 class widows. Helen (Mrs. **Robert S.) Harris** writes that she is well settled in her retirement home at North Hill, Needham, Mass., where she is being "really overwhelmed with friendships." Her grandchildren enjoy visiting her there and make good use of the area dining room and recreational facilities. Helen stays in touch with '28 by regularly reading these Class Notes. . . . Mary (Mrs. **Arthur A.) Nichols** sent a card from her Tampa, Fla., home telling of their lovely weather and about family celebrations. She says that **Frank Taylor**'s cousin is directing a play there so they enjoy watching the "inner workings." . . . Asa (Mrs. **Shikao) Ikehara** sent a gracious note with a New Year greeting. She tells us they had a very cold spell in Tokyo at the beginning of December. This resulted in a cold for her but she recovered in time to enjoy a happy family gathering by year's end. Her daughter and family had then just returned home from California to Tokyo for good. . . . A letter from Allece (Mrs. **Tom) Garrard** has this comment: "When our universities establish priorities with the same long-term dedication to the excitement of scholarship on which MIT has flourished for so many years, our children may be able to cope with the world we live in." . . . Even as we write, Marjorie (Mrs. **John A.) Carvalho** is well into her three-week tour of South America and the Galapagos Islands. Shortly thereafter she expects to move into the Boston area and thus be nearer to her daughter and family. . . . We had a letter from Gertrude (Mrs. **Robert R.) Peatfield** a few weeks after Bob's death. Commenting on his interests Gertrude says: "We were able to enjoy his 50th reunion before his first stroke in 1979. Tech was always close to his heart."

With deep regret we must report at this time the deaths of two classmates: **Gerard A. MacGillivray** died February 23, 1989, only a few hours after his 85th birthday. His son, Kenneth, provided the information in a letter to Frannie Donovan. Gerry graduated in Course 5, chemistry, and always said he was so glad to have made that choice. His professional career began in the textile industry, followed by metallurgy (welding alloys) during World War II years and finished with the gelatin business at George A. Hormel Co. in Austin, Minn. Gerry was an outstandingly loyal alumnus and class member. . . . **Samuel W. Marshall, Jr.** died December 14, 1988. A letter from his son, District Judge John McClellan Marshall of Dallas, Tex., enclosed a copy of the obituary. Sam graduated in Course 6, electrical engineering. In his business career he was self-employed as a consulting professional engineer. His very busy life encompassed many military, civic, church, and social services. Wife Frances, two sons, five grandchildren, and two great-grandchildren survive him. . . . To the families of these, our deceased classmates, we extend our heartfelt sympathy.—**Walter J. Smith,** Secretary, 37 Dix St., Winchester, MA 01890; **Ernest H. Knight,** Assistant Secretary, Raymond, ME 04071

29

Sybil and **Sam Shaffer** of Los Angeles, Calif., write, "The years march on! We are in reasonably good health and may attend the 60th reunion in June. I am retired but still have a few guidance clients including the Advisory Committee of the California State Retail Institute.". . . **Laurence L. Waite** of Los Angeles is not well. He has had three strokes and two operations, which have left him bedridden. . . . **Bill Bowie** of Olmstedville, N.Y., writes, "We have had a fine winter so far. We have very little snow and it's not very cold. I got quite a kick from the letter from **Rolf Zurwell** that appeared in our class notes. Sally and I stopped to see him years ago, soon after he remarried. I was also pleased to read that **Eric Bianche** remarried and is doing so well with his life. We will try to stop at Tequesta, Fla., to see him as well as Mary and **Frank Mead.** I am glad to hear that the response to our 60th reunion has been good. I think most of us realize that the chances of making the 65th reunion are declining, and we might as well attend this one. The reunion plans sound good and being on MIT campus has decided advantages. I have six more letters to write acknowledging gifts of up to $5,000, totalling over $17,500. We are looking forward to a visit with you soon."

Richard E. Bolton of Canada writes, "It was good to get your interesting letter. I had been thinking of you and wondering what you must have been doing for those who suffered and lost their lives in Soviet Armenia during that tragic earthquake. I have a neighbor whose cousin was my roommate at MIT. Her son, Dr. Dennis Drummond of Johns Hopkins, was one of the international team of surgeons who flew to Armenia and Moscow to help save lives and rebuild wounded bodies. I am not related to Denny Drummond, but our families are connected through marriage and I am known to all of them as Uncle Dick. My dear wife, Betty, passed away quietly in her sleep early in the morning of January 23. The previous day, I had driven my son-in-law to the airport early in the morning and then went straight to the nursing home. I spent the whole day at her bedside, saying good night when her supper came in. Bereavement becomes a fact of life at our age, but it is still difficult to accept. Betty's love and devotion have been the joys of my life, despite the sorrow of these last seven years." . . . Professor **C. Fayette Taylor** of Brookline, Mass., has sent a memo to clarify his class affiliation. He is a graduate of Yale and has been on the MIT faculty since 1926 as a professor of mechanical engineering, retiring in 1960. He took only one course in 1929, and the Alumni Association included him in our class.

This year marks the 20th anniversary of my being your class secretary. I was more or less drafted to take on this office by my good friend, **Frank Mead,** who was president in 1969. Upon his urging I accepted the challenge, knowing inwardly that this was not among my best talents. I am thankful that a great many of you responded and sent me news items regularly to keep our '29 column full. Now, after 20 years, many of our friends have passed on, and our numbers are getting less and less by the month. I therefore ask those who are still breathing to remember your classmates are interested in your welfare and well-being. Please send me news of yourself and family.

I regret to inform you of the deaths of the following members of the class: **Jules Leblanc** of Montreal, Canada, on February 4, 1986; **Austin S. Norcross** of Newton, Mass., on January 26, 1989; and **Kenneth W. Martin** of Buzzards Bay, Mass., on January 27, 1989.

Mr. Norcross was a graduate of the University of New Hampshire in 1925, and received his master's degree in electrical engineering in 1929. Austin established the Norcross Corp. in 1946 and relinquished its presidency to his son in 1981 when he became chairman of the board. Vannevar Bush, MIT's dean of engineering, hired Austin in 1926 to teach at the graduate level, an assignment which required him to study nights to keep ahead of the students. His company built and manufactured devices to measure the viscosity of liquids in various industrial processes. He held a number of patents on his devices which have been used by makers of textiles, paper, printing presses, chemicals, electronics, and metal finishing. During World War II, he worked in Washington under Bush, increasing the accuracy of artillery fire, as a member of the U.S. Office of Scientific Research and Development. He leaves his wife, Jean (Hickey), a son, Robert, of Wayland, Mass., and a daughter, Martha Waalewyn, of Dover, Mass.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

30

This month's most intriguing report comes from **Herbert Wampner** in San Carlos, Calif. His activities can best be described in his own words: "If any of the classmates are sitting around doing very little they should get into the age of computers—not just using them with set software but learning how to program them in BASIC. It's a wonderful mental exercise. After retiring I spent about 12 years doing very little that required mental effort. I think my brain was going to sleep. My daughter suggested I investigate computers. At a senior night at one of our local schools a 12-year old girl taught me hands-on for two hours. I was hooked, joined a senior class and after two years started teaching. I keep very busy teaching five classes of seniors. . . . at two senior centers. My oldest student (several years ago) was 92 and still talks about coming back. Also I belong to two computer clubs (ex-president of one)." Further he belongs to several senior organizations and shows them slides at least once a month of photographs he has taken. Herb retired in 1970 as development vice-president and board member of Reichold Chemicals Inc., which has since been purchased by its Japanese affiliate.

Two Florida reports came in this month, one from **Sol Uman** in Pompano Beach and the other from **Carlton Vanderwarker** in Boca Grande. The Umans have maintained contact with the **Morris Shaffers** and were looking forward to a visit by the Shaffers. But Morris' wife unfortunately tripped and broke an arm, thereby causing the trip to be cancelled for the present. . . . As previously reported Carl Vanderwarker retired in 1973 as vice-president of American Mutual Insurance and was active in public affairs in New Canaan, Conn., where the Vanderwarkers lived. Having established a winter home in Florida last fall, Carl is now devoting more time to golf, fishing and bridge. . . . Peg and **Bill Waite** divide their time between homes in Wilmington, Del., and Vermont. Bill went back to his 60th reunion at Wakefield, Mass., High School and there met **Alan Vint,** who was both a high school and MIT classmate. Bill has returned the "blue card" enclosed with the January 60th reunion mailing, thus indicating that he plans to attend.

The responses to the 60th reunion letter have produced a respectable number of items for the Notes, most of which I plan to hoard for future issues. This month I shall comment on three heart-warming letters we have received from widows of classmates. Nina (Mrs. **Wallace G.) Hope** writes from Boone, Iowa, that Wallace (see January 1989 notes for obituary) "looked forward for a long time to attending his 60th reunion. . . . He died on June 24th in Blair, Nebraska, while we were en route home from a visit with our daughter Carolyn. . . . Wallace was alert physically and mentally to the very end of his life. . . . I would like to add that Wallace made a name for himself in his chosen field of insulating materials and was a real credit to himself, his family, his community and most of all to MIT." . . . Virginia (Mrs. **Allen) Shepherd** writes from N. Smithfield, R.I., that Allen (see October 1988 notes for obituary) took early retirement to enable them to travel to five continents. She continues: "We both enjoyed the reunions which we were able to attend, and I am sure the 60th will be the usual great event. With my best wishes for its success." . . . Janet (Mrs. **Lon) Verveer** writes from Downers Grove, Ill.: "Thank you so much for including my name on the roster, but it will not be possible for me to join you—in fact without Lou (see May 1987 notes for obituary) to pave the way and to renew old friendships, I should be absolutely lost. . . . With all good wishes for the success of the reunion and for the future of the members of the class of 1930, and for MIT!"

In reviewing the class roll last spring I came upon the name **C. Thurston Ramsey,** which reminded me that I had a schoolmate named Thurston Ramsey at the Flatbush School in Brooklyn more than 70 years ago. A brief exchange of letters elicited the fact that he had indeed attended the Flatbush School and that we had both participated in the celebration of the false armistice in November 1918. My surprise at his failure to answer my last letter has now been explained; Thurston died in Melbourne, Fla., on October 18, 1988. It appears that immediately after graduating from MIT he joined the staff of Pan American and continued working for PanAm in engineering, operations and administration until his retirement. During his career he was involved not only in the initiation of air travel in the Pacific, but also his last assignment at Patrick Air Force Base enabled him to be involved in the birth of the Space Age. He is survived by his wife, Edna; a son,; two daughters, and 10 grandchildren.—**Gordon K. Lister,** Secretary, 294-B Heritage Village, Southbury, CT 06488

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We have just a couple of notes from Alumni Fund envelopes. **William Henry Weeks** writes that he is a member of Quiet Birdmen, a pilot organization, and Phi Delta Theta. . . . **John Robert Outt,** who spent 40 years in engineering, made several predictions about the future, gave a definition of utopia, and says his ken is global having visited Europe and India. His present job is taking care of one acre of fertile land in suburban Philadelphia. He writes: "The Great Lord has enriched our lives with all that really matters. Like Confucius at 80, my wife and I are content. We have a daughter who is a Syracuse alumna, a grandson who is a doctor, and a granddaughter who is a Mass General nurse, and one great grandchild. My present hobby is reading Barron's; my previous hobby was writing science fiction about real people on a planet which is Earth's twin. Apologies to Gulliver. It is a return to Eden. Also writing sociological essays."—**Edwin S. Worden, Jr.,** Secretary, Box 1241, Mount Dora, FL 32757

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As you know, our mini-reunion had to be cancelled because the American Cruise Line filed for bankruptcy. The proposed trip was cancelled, and all monies were returned. We understand that MIT is planning a mini-reunion program for all 50-year-plus classes in conjunction with Technology Day activities. If anything materializes, we will keep you informed.

I spoke to **Warren Little** on the phone. He and his wife had been hospitalized in the past year, but they are well along on the road to recovery now. Warren has a good sense of humor. . . . **Robert Phemister** is retired and plays a respectable game of golf. His wife, Nora, is in fair health. He has three married boys and nine grandchildren. . . . I tried to phone **Robert Prescott, Sidney Friedman, Frances Gowen,** and **Robert Dunlavey** during the telethon, but they were not home. . . . **Carl Wahlstrom** and his wife, Philomena, celebrated their golden wedding anniversary with a trip that covered Tahiti, Australia, New Zealand, and Honolulu. New Zealand was beautiful, but Carl thinks Norway is still tops for scenic beauty. That's where **Rolf Eliassens** and his parents came from. . . . **Arthur Marshall** received an invitation from the Prime Minister of Israel to attend a conference in Jerusalem to establish a solid Jewish position for peace. We'll look for your report, Arthur.

We have learned that **Walter Lazer** died in February of 1989. The final 15 years of his 43-year career was with the Instrumentation Laboratories of Lexington and Watertown. In retirement, he spent the past six years as a volunteer science teacher at the Hillside School in Needham, giving demonstrations of the principles of physics. He had worked with more than 300 fifth graders, devoting 1,155 hours to the school in a single year. Mr. Lazar was proud of one student's comment: "You make science more fun than recess." For his dedication to science and the young, he was chosen a regional finalist in a national program that recognizes outstanding volunteers nationwide. He leaves his wife, Jane, and son, Ken.

Benjamin Chadwick and his wife still do a lot of traveling. In February, they went to Sydney, Australia, and spent three weeks in the Sepec River area and the Solomon Sea. In June, they will be on the MIT tour of the Canadian Rockies.

Maybe the time has come when we the living members of our class should write a "letter of remembrance" about a classmate of ours who is no longer with us. You can write about any shared experience or observation you want to make. I will start off by recalling a classmate of ours.

William Adelson was a cheerful fellow and always good company. He had to struggle to keep up in his schoolwork. He did not know whether he would graduate until the very last moments. In 1932, he got a job with a shoe manufacturing company in Lewiston, Maine. I remember he was coming home to visit his parents and I was to call him on Saturday morning. When I called, his father said that Bill had been killed in an automobile accident on Friday. I believe my hair stood up! I visited his parents occasionally for a few years and found it a very trying and sad experience for me.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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The only news your secretary has received is from our president **Dick Fossett,** who reports on his cruise to Antarctica from a spot near Cape Horn with about 150 passengers, mostly Cal Tech and Harvard alumni and spouses. He wrote about a stormy crossing to the Drake Passage with glaciers and icebergs everywhere, and trips ashore to observe penguin colonies and seals, and visit active and abandoned research bases.

OBITUARIES: **Terry Smith** died October 28, 1988. He is survived by his wife at 6929 Penn Dr., Dublin, CA 94568. . . . Maj. Gen. **William E. Potter** died December 5, 1988. He served in the U.S. Army Corps of Engineers planning the Allied invasion of Europe. Later, he was employed by Walt Disney Productions. "Without Joe Potter there would be no Walt Disney World today." Potter earned a degree from West Point; he was president of the Panama Canal Co. and executive vice-president of World's Fair prior to Disney experience. Mrs. Potter resides at 931 Ventura Ave., Orlando, FL 32804.

Have we lost our ability to communicate? Please bare your peripatetic soul to ye secretary.—**William B. Klee,** Secretary, Box 7725, Hilton Head Island, SC 29938

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Leslie J. Fitz Gibbon writes from Garden City, N.Y., where he has lived since 1936, that he has been an employee and owner of Pilot Packing Co., Inc., which handles railroad supplies. He is currently the president. In 1971 he was elected first honorary member of the Fluid Sealing Association, his company's trade association. He is married to Sarah Miller Rich and they have one daughter and one son. Tennis has occupied an important place in his life beginning at Longwood in Chestnut Hill where he and his son won the National Father and Son Championship in 1967. He has been active in the USTA as a director, treasurer, Brittania Cup team captain and currently is a member of the USTA Davis Cup and Olympic Committees and the Senior Tennis Council. He was inducted into the Eastern Tennis Assoc. Hall of Fame May 13, 1988.

John C. Alden sent us a capsule report of his interests in railroading and travel. He worked for the Boston and Maine most of his business life and is a life member of the Railway and Locomotive Historical Society of which he served as

secretary. He is a member of the Audubon Societies of Massachusetts, New Hampshire, and Rhode Island. He is a life member of the Appalachian Mountain Club and in 1977 he and his wife Anna took an AMC trip to Nepal. He is also a member of the Sierra Club. . . . **James W. Libby** writes from Hockessin, Del., that he has been keeping himself busy as ever since retirement with sailing, gardening, reading, handcrafts and has also served on the boards of the Chesapeake Bay Girl Scout Council, the Delaware Nature Society, and the Red Clay Valley Association. The latter two are dedicated to the improvement of the environment and education.

I am very sorry to have to report to you the death of Rhoda Nelson, wife of our class president **Bernie Nelson,** on March 1 at their home in South Harwich after a brief illness. She always contributed a great deal to our class reunions and meetings, and we shall miss her. She is survived by her husband, two daughters (Deborah Aylesworth of Wellesley and Elizabeth Duenas of Holmdel, N.J.), and three granddaughters. Bernie was at Mass. General for a catherization on February 27 and 28 and managed to talk with Rhoda by phone the evening of the 28th and arrived home the next morning an hour after she died. Bernie faces triple bypass surgery in May and says, "If everything goes alright I can stay on until our 55th as president." His two daughters had a small group as a surprise at Jimmy's Harborside for his 75th birthday on March 16.

I have been keeping in close touch with **Ned Collins,** who wants to move to a warm climate, by supplying him with all the information I can about San Diego County. Some others of you who live in the sun belt might give him some ideas, too.—**Allan Q. Mowatt,** Secretary, 715 No. Broadway, Apt. #257, Escondido, CA 92025

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Letters—good-news ones, bad-news ones, and one with both good and bad. **Roman Ulans** (Course VI), on board a freighter-cruise ship wrote on February 8 from Japan that his January *Review* was forwarded with other mail to Korea, and he had just finished reading Class Notes. Ro and wife Morwenna sailed from Long Beach, Calif., stopping at several ports in each of several far-east countries. They recommend "the accomodations and general ambience which can be described as casual elegance. . . the food good and the crew pleasant. . . if you like a slow boat to China and take some good reading." They were winding up their 50th wedding anniversary celebration, which began with a party in California and all six children and eight grandchildren attending. They broke their trip in Korea to spend three weeks with a son who is stationed there. Roman is hale and hearty, and in between travels he plants and cultivates trees on their 10 acres in Pipersville, Pa.

Responding to the Alumni Association questionnaire, **Jack Ayer** (Course VI-C) enlarged a bit on his brief reference to activities in the 50th Reunion biography. He is active in the Alumni Club of Colorado (president three years) and in Scouting and Explorers. He tutors fifth graders, works with "People Who Care" at a half-way house, and does other charitable and church work. He likes four-wheel-drive exploring in the mountains for camping and photography, and he bakes his own bread! So he and I have to get together to exchange recipes and techniques. At high altitudes (Denver is the "Mile High City" and it is 7,000 ft. here in Santa Fe) all standard procedures seem to be suspect.

Loreto Lombardi (Course XVI) replied that he is 75 and retired, and on the telephone added that he has been tutoring in mathematics at Brookline High School for the last six years. His career included Glenn Martin Co., Curtiss Wright, Cornell Aeronautical Lab, Bell Aircraft and Raytheon. Course XVIers of the class seem to have followed their undergraduate choice more than VIers such as myself, and I imagine that World War II and the subsequent rapid advances in aeronautics made heavy demands for their expertise.

Letters from **Eli Grossman** and **Herb Borden** tell of **Leo Kramer**'s death February 20 in his sleep, apparently of heart failure. Eli had seen Leo and **Bill Rousseau** only five days earlier at an MIT Club of Palm Beach meeting, and 10 days earlier had lunch at Leo's club. "After lunch he showed me his paintings and his new computer. I was impressed with both. At that time I learned that Leo had won a scholarship, while in high school, to the Fine Arts School in Boston, and attended classes there during high school days. At MIT he had a hard choice to make between architecture and mechanical engineering; he chose the latter. He was enjoying painting, his computer and golf, among other things before he died." I can vouch for the painting, having seen several of his works when Phoebe and I visited last year (see October Notes). Hats off and cheers for Leo's life and a productive career! Instructor at the Institute and Tulane, war production at National Fireworks, management for 30 years at Raytheon, and since 1960 coping with the disabling illness (Multiple Sclerosis) of his wife Frances. This has required nursing home care for about the last 10 years. Leo adjusted his life in ways that held the respect and devotion of his family and many close friends. His dear friend Lillian Morse, whom we all met at 50th reunion, was mentioned in the death notice by daughter Lois and son Arnold.

Herb Borden's letter told of his trip with Kitty to Hawaii, where he paraded with the Boston Aleppo Brass Band of Shriners through Waikiki. This is a reprise, after a 60 year hiatus, of his clarinet and saxophone playing as a youth, and continues with appearances at the Shriners' maple sugar weekend and the New Hampshire-Vermont all-star high school football game. Herb!—bring your instruments to our 55th reunion, and find some other talents among classmates, for combos after the usual events. We can have an all night ball like the old days.

The Institute's *Spectrum* publication (part of the *Campaign for the future*) last summer carried a feature article on the Course X Practice School, established in 1916. It told of the great achieveents of many graduates, but also the problems of finance for both MIT and students. A program to endow fellowships, begun several years ago, is well on its way to fulfillment, and **Bill Rousseau** is one of several pace-setting endowers. I imagine that Bill's annual collection and circulation of letters (1988 is volume No. 52) from fellow X-Aers has helped create a unique esprit among the group, helping to support the program which gave them hands-on experience on difficult problems of chemical plants around the country.

To all classmates whose names have not appeared in these Notes during the past five or more years—please let us hear from you. I shall continue my travels and visit as many as I can, but it would take several years to do all. We may not live that long.—**Frank L. Phillips,** Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson,** Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Paul W. Allen, 1175 Glen Oaks Blvd., Pasadena, CA 91105, retired as executive vice-president, Cyprus Mines, March 1, 1980. He is now working as an independent mining consultant. Wife Marjorie's main interest is Gamble House, and Wa AIME. His sports are trekking, mountain climbing, and cross-country skiing. . . . **P.H. Dreissigacker,** 814 Hollyhock Ln., Orange, CT 06477, writes, "Bearer of sad news again. Just received word of the death of **Gray Jensvold** in Morrisville, Vt. (See below.) You may remember that Gray wrote the class at the time of our 50th that he was ailing with Parkinson's disease and unable to travel. Morrisville, Vt., is quite a reunion place for sons of the class of '37. My two sons moved to Morrisville with their business 12 years ago, quickly met the son of **Bob Weppler** and also the son of **Gray Jensvold,** not knowing at the time that their fathers were class of '37. My wife, Ruth, and I had visited Gray and his wife, Elizabeth, prior to his illness but not recently. On another class contact, I attended an MIT club meeting last Wednesday in Meriden, Conn., a joint meeting of the MIT clubs of New Haven and Hartford. As treasurer of the New Haven Club, I was communicating with the treasurer of the Hartford Club, Peter Klock, '65, only to learn he is the son of our classmate **Nancy Klock.** Some small world isn't it? Nancy, as reported some years ago, is no longer living."

Ernest Ferris, 146 Greenleaf Dr., Oak Brook, IL 60521, retired in 1983 as vice-president of engineering, Spring Division, Borg-Warner. Wife Alyce's main interest is grandchildren and their sons; they just had two grandchildren last year. Ernest is semi-retired working part-time in a small japanese trading company. Currently he is trying for another patent on one-way clutches. His sports are bowling, golf, racquet ball, and skiing. He writes, "Sorry to see MIT getting so big, exclusive, and expensive. I still contact **Robert J. Brauer, Bill Bakarian, Dom Cestoni, Fred Ferrary, Ray McFee,** and **Mike Zinchuk**. . . . **Robert C. Glancy, Jr.,** 620 W. Huntington Dr., #133, Arcadia, CA 91006 writes, "I have spent a lot of time caring for my wife, who was hospitalized four times from November 1987 through May 1988 and requires heavy medication to control unstable angina. We spent August and September at our cottage in Meredith and I swam two or three times a day even when the air was 41 degrees F. My formula for chilly swimming is when the sum of the air temp and water temp is 100 degrees F. or less. This month, January, I start my annual IRS training for tax counseling."

Art Zimmerman, 3356 Lansmere Rd., Shaker Heights, OH 44122, is semi-retired and working as executive director, Cleveland Commission on Higher Education. Wife Agnes' main interest is church, garden club, and hospital guild. His sport is tennis three or four times a week. He writes, "We're proud and happy grandparents of another granddaughter born in August 1987. Hope to go to Hawaii for our 45th anniversary in September. Recently went to Wisconsin to see our daughter and family." A letter of Art's was printed in the 12/11/88 issue of the Cleveland *Plain Dealer* in which Art expresses his dismay with the harassment by the liberal press of Dan Quayle partly because he is a member of a wealthy family. He added that Roosevelt and Kennedy, both democrats from wealthy families, were not handled so poorly.

It is with regret I report that **Gray Jensvold** died January 19, 1989, at his home in West Elmore, Vt., following a long illness. Gray was born in Oswego, N.Y. He moved to Vermont in 1947. He had a lifelong interest in aviation, skiing, and ham radio. He was active in the early days of the Mount Mansfield Ski Club and the Stowe Flying Club. He was a member of the Number 6 Club and the Lake Mansfield Trout Club. He is survived by his wife, Elizabeth Fish Jensvold; his five children, and six grandchildren. . . . I regret to report that **David N. Summerfield,** 15100 W. Cleveland Ave., #77, New Berlin, WI 53151, died November 7, 1988. . . . I also regret to report that **George B. Wemple** died in New York City on April 22, 1988, at the age of 73. He studied in Course XV, was a Marshall of the class of 1937, and a member of Delta Kappa Epsilon and Tau Beta Pi. After MIT, he worked for National City Bank in New York City until called to U.S. Army active duty in 1940. He was discharged in 1945 with the rank of Lt. Colonel and then returned to commercial banking. In 1956 he married Suzanne Fonay who survives him with their three children, and two grandchildren. At the time of his death, he was the sales representative for New York and New Jersey for American

Teller Machines. He and his family enjoyed summers in their "cottage" at Point of Woods on Fire Island where he taught his children tennis, sailing, and swimming. During winter holidays they skied at Magic Mountain in Vermont. Wemple also is survived by a brother Edward, of Darien, Conn., and a sister.—**Lester M. Klashman,** Secretary, 289 Elm St., Apt. #71, Medford, MA 02155

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Some time ago we asked about classmates who have had relatives who attended MIT. The latest to respond was **Ed True.**

His uncle, Osmond S. True, was of the Class of 1922. Then there were several cousins: Salmon W. Wilder, '91; Lowell Wilder, '01; Albert O. True, '05; H. Nelson Keene, '17; Philip Wilder, '23; and by marriage, Nelson's roommate, C.W. Hawes, '17. If Ed were to include all the descendants of Henry True, who came to Salem from England in 1644, there's no telling where this would end. By the way, he tells me our **Lloyd Bergeson** is also a descendent of the same Henry True—how's that for being distantly related?

On March 29 several members of the 50th reunion committee had lunch at the Faculty Club. Our president, **Horace Homer,** led a discussion to fix plans for the June mini-reunion, to get suggestions for our 55th in '93, and to verify which classmates were in the official class picture of last June. Present were **Horace, Haskell Gordon, Frank Gardner,** Marie and **Paul O'Connell,** Sandy and **Lou Bruneau,** Nancy and **Dave Wadleigh,** the Severances, and Jean and **Ed Hadley** and a charming daughter—the latter three enroute that afternoon to Turkey.

We were lucky that many could attend in view of travel schedules. The Gardners recently spent 12 days in Egypt, starting at the Sudan border, to the Aswan Dam area, Luxor/Karnak Temple of Kings and Queens, Cairo, the Giza pyramids, and the Tut-ankh-amen exhibit at the Egyptian Museum.

Lou and Sandy had been to Switzerland and were recently at a member-guest golf tourney at Johns Island, Fla.

The O'Connells took a leisurely five-week motor trip down the Coast to The Keys—visiting historical sites along the way; then spent a month in Fort Lauderdale this winter.

Haskell and Ina for a five-week period during February and March vacationed at the Long Boat Key Club, enjoying golf, tennis, swimming, and many concerts at nearby Sarasota.

Congratulations are in order for **Ray Popkin-Clurman** on his marriage to Anne Margaret Watkins January 13 in his home town of Ganges, British Columbia.

Now for the sad news. I must report the recent deaths of two of our classmates: **Lyndon Crawford** of Arlington, Va., and **Peter de Florez** of San Francisco.

Lyndon transferred from Harvard in his junior year and graduated in naval architecture and marine engineering. He died January 18. Lyndon had been Undersea Warfare Analyst for Potomac Research Corp., Operations Research, Inc., and Electric Boat Division of General Dynamics Corp. He leaves his son, a daughter, his former wife, Victoria; three grandchildren, and his brother, Bruce, who thoughtfully sent us this report.

We were informed of Peter's death February 21 by his closest friend and classmate, **Cornie Roosevelt.** For years Peter has repeatedly undergone surgery on his back—always in hope the next operation would provide at least some small measure of relief from the constant pain he has endured so stoically. We who saw him intermittently noted to our sorrow that his mobility seemed to have decreased since our previous visits. In spite of the pain and what had to be great disappointment after each operation, his extraordinary sense of humor stood him in good stead, and for us all he made each telephone call and visit a delight. For his many friends in the class, more about Peter next issue.—**Don Severance,** Secretary, 39 Hampshire Rd., Wellesley, MA 2181; **Ed Hadley,** Assistant Secretary, 50 Spofford Rd., Boxford, MA 01921

George Cremer, '39 (above left), was researching in his library and found a picture of classmate Dick Feynman and himself, taken in the mid-1950s. The occasion was a special course for outstanding students at his localjunior high school. He wrote: "I invited Dick to come and stimulate the gifted group—and did he ever!"

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The Fiftieth Reunion Class Book for MIT Class of 1939 arrived. It was beautiful and splendid. It included 170 biographies from **John Alexander** to **Abraham Zimmer.** There were 87 pages of special features. Classmates who did most of the work include **Fred Grant, Fred Schaller, Aaron White, Irv Peskoe, Pete Bernays,** and **Ernie Kaswell.** These six outdid themselves. One example of their attention-riveting gems-manship is found on page 59 under "Health and Recreation" (summary of responses to a long questionaire): "On an optimum scale of 5.0 you give your general health a 4.2, physical fitness 3.7, weight and blood pressure 4.0. To the question 'How's the sex life?' we modestly claim 2.5. This does not include the '10 to the fifth power' immodestly mentioned by one living legend. An appropriate ceremony might be planned during reunion time should this soul abandon anonymity." Our classmates, many of whom are past their 70th birthdays, will be watching for this "appropriate ceremony!" If either of the fore-mentioned six or the living legend himself (or herself?) produces startling and publishable follow-up at reunion your secretary's Class Notes may be a bit unusual, come the November edition of *Technology Review.*

Mike Herasimchuk and **Morrie Nicholson** have been producing "MIT 1939 Course III/XIX Affinity Group Sporadic Newsletter" for some months. The March 21 edition reports **Will Jamison**'s career included work as a dirty-faced coal miner before he became general manager and vice-president/operations and sold his mine and operations to Consolidation Coal Company. Mike and Morrie succeed in assembling most-interesting newsnotes. Also, special gifting by their subscribers to MIT exceeds $60,000.

Pete Bernays started a newsletter for Course V and chemist '39ers and reports a "special breakfast will be at 7:15 am, Friday June 9, at McCormick for Course V 39ers and their guests." Pete's newsletter continues: "Mark Curgen retired to South Carolina and will attend reunion. . . . **Mel Falkof** started a two-year assignment with International Executive Service Corp. in Cairo, Egypt, but will interrupt his camel-riding around the Sphinx and Pyramids to attend reunion. . . . **Esther Garber** retired from U.S. Army Natick Labs, continues as archivist of the Northeastern Section of the American Chemical Society, and will attend reunion. . . . **Art Olson** will attend reunion. . . . **Ruth (Berman) Pitt** earned a PhD at University of California, San Diego, practiced psychology, and is writing a book about her researches of the past 12 years. . . . **Jim Schulman** published 100 papers and received 15 patents. His career included assignments at U.S. Office of Naval Research in London and as Scientific Director, ONR."

Seymour Sheinkopf reports Arline Weiss is thoughtfully sending slides taken at past reunions. During his lifetime **Ike Weiss** made contributions to Mack Truck Co. and to the executive staff of General Motors, Truck Division.

We are saddened by news of the deaths of six classmates: The *Boston Globe* reports the death on January 20, 1989 in Cambridge, of **Reevan Spiller.** "Mr. Spiller was former comptroller of the combined Jewish Philanthropies of greater Boston. He had retired in 1979 after 22 years with the organization. He had been head of the citywide Parent Teachers Organization and past president of the Cambridge Jewish Community Center."

Lawrence G. Peterson, '36, forwarded a clipping from the *Schenectady Gazette* reporting the death, on March 3, 1989, of **Bill DeLia.** During World War II Bill worked for the U.S. Army Corps of Engineers in British, Dutch, and French Guyanas. In 1953 he moved from New Hartford to Northville, N.Y., and bought Sacandaga Park. He founded B. William DeLia, Inc., Construction Company and built many roads, bridges, and highways in New York.

James Ferry died February 25, 1989. At MIT he graduated in Course VI-C and managed the fencing team. During World War II he worked at the MIT Radar Lab. In 1958, with two others, he founded Aspen Airways to fly between Denver

and Aspen. As vice-president he represented Continental Aviation in the Industrial Liason Program at MIT.

Lydia Laurent writes: "**George J. Laurent** died March 1, 1988, at Wrightstown, Pa. At MIT he earned membership in Tau Beta Pi and Eta Kappa Nu. During World War II he served in the U.S. Navy as Commander. He was a licensed professional engineer and held patents in radar and automation. His career included major works in technical areas of electronic warfare, automated guidance systems, radar, and electrical engineering design of hospital anesthitizing and critical patient areas."

Mary Salmon wrote from Chicago to report the death, on December 23, 1988, of **John L. Salmon.** "John worked on many major Chicago construction projects. He helped build Chicago Transit Authority subway lines and local bridges. He was a member of many engineering organizations including the Groundhog Club and the Moles, two national clubs for underground engineers, and he was active in the MIT and Union League Clubs of Chicago."

Clark E. Taylor, Jr., died February 3, 1989, at Wilton, Conn. There were no details.—**Harold R. Seykota,** Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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A recent article in a Draper Lab publication noted that **Hal Laning** was recently appointed senior technical advisor reporting to the executive vice-president. Since he joined Draper in 1945, Hal has held a variety of senior technical and administrative responsibilities in analysis, computation, computer development, and engineering applications of computers. Recently he has been head of the Automation Technology Department. Among his achievements are unique pioneering research in computer science and missile guidance. He developed the first algebraic compiler, conceived the theoretical development of the guidance system used in the Thor and Polaris missiles, and participated in the design of the Apollo guidance computer. He co-authored a book used as a graduate textbook at MIT, and in France, the USSR, and the People's Republic of China. Hal is a member of the National Academy of Engineering, American Mathematical Society, American Institute of Aeronautics and Astronautics, Association for Computing Machinery, Institute of Electrical & Electronics Engineers, the Institute of Management Sciences, and the Society for Industrial & Applied Mathematics.

W.H. Krome George figures prominently in a recent book about the lessons to be learned from the corporate history of Alcoa. George was CEO there in the 1970s. The book is *From Monopoly to Competition: The Transformation of Alcoa,* by George David Smith, Cambridge University Press, NYC. It is a fascinating story for those who want to learn about this phase of industrial history, as well as our classmate.

David R. "Beano" Goodman sent me a copy of some of his musings, reviewing his life and times. He suggested that other class members do something similar and exchange their writings at next year's 50th reunion. If enough people do this, perhaps they can all be compiled and distributed to class members after the reunion.

The Alumni Association has sent me a list of known surviving spouses of class members, but thinks it is incomplete. If you know of any widows or widowers of classmates, please send their names and addresses to me so I can bring the list up to date.

A note from **Dan Karp** of Great Neck, N.Y., says, "Last July 1 I retired from DeVore Aviation Corp. after 15 years as executive vice-president. Prior to DeVore, I was vice-president and general manager of the Aerospace Division of Universal Oil Products Corp. Since retirement, I have kept busy doing consulting work and working as a member of the board of governors of the Technion-Israel Institute of Technology. Committee work keeps me occupied. I am looking forward to our 50th reunion, and the opportunity to become reacquainted with former classmates."

Richard W. Cobean of Libertyville, Ill., sent me a letter with a lot of information about his career. He retired in 1986 from Baxter Travenol Laboratories after 12 years. Currently he is doing consulting engineering for his old firm and two other companies. When he has spare time, he works on completing a Rutan VariEze airplane that will enable him to fly with wife Helen around the country. The journey will include a visit with his four children and three grandchildren in New England. Earlier in his career, Dick worked for General Electric, Picker X-ray, General Electric again, G-V Controls, Narco Scientific Industries, and then Baxter. He reports that both he and Helen are in excellent health, and are definitely coming to our 50th reunion. . . . By the end of February there were 117 replies to the reunion questionnaire. Of these, 76 said they were coming, 15 were unsure, and 26 were not coming. By the time you read this we will probably have many more responses, so attendance looks good. Many of the questionnaires included personal information, some of which will appear in this column and more in future columns.

From Kemah, Tex., **George B. Bradshaw, Jr.,** notes that he retired in 1980. He has built a new house on Galveston Bay, was widowed in 1986, and is now engaged. He plays lots of golf, does consulting, community work, and gardening.

Clem Burnap of Alameda, Calif., is still handling sales for four small engineering companies. After visiting 106 countries for work and travel, he is now planning his first cruise from Buenos Aires to San Juan, Puerto Rico. He is going to attend his 50th reunion at Dartmouth, his 55th at Exeter, and his 50th at MIT in 1990.

In Cape Coral, Fla., after retiring twice and then returning to work, **Samuel P. Card** is now practicing full time as a registered professional engineer and consultant to major office-park developers. . . . **Delos B. Churchill** lives in Old Saybrook, Conn. He hopes to spend some time with us in Mystic while we reunion there June 4-7, 1990. In the meantime he is very busy with administrative duties in yacht, golf, and racquet clubs, as well as with grandchildrens' school exercises and plays.

Charles M. Edwards and his wife are still working hard at running their winery in Santa Rosa, Calif. They are considering providing The Merry Vintners Chardonnay from the winery for a reception and social hour before dinner at the reunion. They still hope to retire "one of these days." . . . **Harry A. Ferullo** retired to Cummaquid, Cape Cod, after 34 years with Bell Aircraft Corp. and its successor, Bell Aerospace Textron.

From Houston, **Morris I. Gabel** writes that he retired in 1982 after selling his company, Engineered Grating, Inc. His son, MIT '65 and Ph.D. Brandeis graduate, is senior associate dean at the College of Arts and Science, George Mason University, Fairfax, Va. Morris's daughter recently graduated from law school and is now practicing in Houston. Her daughter is a second-year law student at the University of Texas. Morris has three grandsons. He and wife Eleanor take a major one-month trip every year to the most remote destination possible—i.e., Far Western China Silk Road, Tibet, Sikkim, Bhutan, Sri Lanka, Hindukush, Pakistan—plus many not-so-obscure spots. He is patiently awaiting the 50th reunion.

Richard D. Gerges retired from Rohm and Haas Co. in 1982, and now lives the good life in Mount Dora, Fla. . . . **William T. Green** is still chairman of Double Seal Ring Co. in Fort Worth. He started working there during the summer of 1937 for 20 cents an hour, and doesn't ever intend to retire. After graduation, he worked for Lockheed Aircraft as a project flight test engineer until he was released in 1945. He then went to Double Seal in New York until he was transferred to Texas.

In Des Plaines, Ill., **Joseph H. Greenberg** is supposed to be retired, but is still working as a consultant in heavy metal-working plant design. Unfortunately, his wife has been in a nursing home for five years in an advanced stage of Alzheimer's disease. . . . **Alvin Guttag** is still running, and campaigning for awards for runners in various age groups to 80 and over, in Bethesda, Md. He has served as Course V secretary since graduation, and hopes to continue through the 50th. He sends an annual Christmas card to all Course V members.

From Dayton, Ohio, **William H. Hagenbuch** writes that he served as an electronic countermeasures officer, European Theater, in World War II. Then for over 40 years, he made rope and twine for a semi-family company, H & A, Inc. He retired as president in 1985. Bill and wife Grace have four daughters and two grandchildren. . . . **Donald R. Harper** is now fully retired from his consulting as a P.E. He and his wife spend winters in Cape Coral, Fla., and summers at their home in Vermont or traveling. They both enjoy golf.

Fredyum Henrickson, Jr., is a consultant to the alkali industry in Syracuse, N.Y., when requested. . . . **David M. Heskett** has been retired for over eight years in Bismarck, N.D., and enjoys it. He has learned that it is not necessary to be ultra busy to be happy. . . . **Fred J. Johnson** retired from du Pont in 1979 in good health. He is living the good life in Englewood, Fla.

We will include more notes next month.—**Richard E. Gladstone,** Secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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C. William Hargens, Jr., gave a party for **John Mullen, John Murdock,** and **John Goppelt.** The grand occasion was the send-off for the Mullens to their new winter home in Naples, Fla., after many years in the Philadelphia area. . . . **Robert Wallace Blake**'s narrow defeat in his run for Congress is a story that would interest many classmates. Bob was falsely accused of being a recruiter for the CIA. Bob's address: 900 Warren Ave., N., Suite 401, Seattle, WA 98109. Bob had surgery during the Christmas holidays, the operation was fine, but recovery is slow. . . . **Joseph G. Gavin, Jr.,** was re-elected to a two-year term on the board of directors of the Charles S. Draper Lab.

Raymond W. Ketchledge died in October 1988. Ray was executive director of the electronic switching section and first director Bell Labs Indian Hill at Naperville. During World War II he developed the Mark 24 torpedo and other infrared devices to locate enemy ships. Ray became famous for guiding the development of the world's most modern computer-controlled electronic switching system for telephone operations. Ketchledge left Indian Hill in 1975 to return to Bell Labs in New Jersey. There he continued working on military systems development until his retirement in 1981. Ketchledge was the recipient of numerous honors for his research and development work. These included the Alexander Graham Bell medal and membership in the National Academy of Engineering. The original buildings of the Indian Hill Labs represent now but a small portion of the 22-year old facility Roy directed. This major research facility of the Bell Lab complex has grown very large since that time.—**Joseph E. Dietzgen,** Secretary, Box 790, Cotuit, MA 02635

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A letter from Mrs. June Morrison in Tavernier, Fla., reports the passing of her husband, **Richard B. Morrison,** on January 23. Richard served in the U.S. Navy during World War II, and then joined the faculty at the University of Michigan, Ann Arbor, where he received a Ph.D. in aeronautics engineering in 1952. He was test director for the Atlas and Thor Able missile programs at Cape Canaveral, and later was employed by NASA as director of launch vehicles. We extend our condolences to his family.

To assist me in writing a biography of bandleader Jan Savitt (1907-1948), I would like to hear from any alumnus who remembers the Savitt band playing for an MIT dance at the Hotel Statler on May 12, 1944, or any other occasion.—Thurlow Cannon, 5 Fairview Blvd., Ft. Myers Beach, FL 33931

Here's an update to the periodic **William R. Thurston** report. Bill, Chairman of Genrad, Inc., has been named by Gov. Dukakis to the board of directors of the Massachusetts Technology Park, Inc. The Technology Park is a quasi-public organization created in 1982 to foster the development of current and emerging technologies through partnerships among private industry, universities, and state government.

I received a short letter from **B. David Halpern** of Warrington, Pa., summarizing his career over the past 45 years. After the war, Dave left his chemical engineering position at Rohm and Haas to get a Ph.D. in organic chemistry from Notre Dame. He then founded a fine chemical synthesis firm which he later sold to Borden Chemical Co., at the same time becoming the research director of Borden's Central Research Lab in Philadelphia. He left Borden in 1963 to start another venture, Polysciences, Inc., which he still heads as president. Polysciences manufactures and sells a wide range of organic chemicals for medical, diagnostic, industrial, and other specialty applications. Starting in Dave's garage, Polysciences has grown to several buildings on ten acres, with a staff of 90 and a 1988-89 product catalog 1/4" thick. Dave's wife Ruth is the company's director of personnel. She and Dave have five grown children.

Spring and summer greetings to all.—**Bob Rorschach,** Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Trigg Noyes reports that he has retired from IBM after more than 33 years. He wrote at the time that he planned to attend the 45th reunion with other Deke classmates.

We regret to report on the passing of three of our classmates. Charlotte Benjamin writes that Reverend **Roland Benjamin, Jr.** died on December 9, 1988, in Boca Raton, Fla. He is survived by his wife, Charlotte, two daughters, and two grandchildren. He was buried in Washington Memorial Cemetery in Valley Forge, Pa. . . . Ellen De Kanter, wife of **Scipio De Kanter** reports that he died on January 22, 1989, of a heart attack at Missouri City, Tex. . . . **Chester Woodward** died last February. We extend our deep sympathy to their families. They will be missed by their families and classmates.

By the time you read this, we shall have had the 45th at Cambridge and Bermuda. The reunion committee hopes that all had a great time and are looking forward to the 50th.—Co-secretaries: **Lou Demarkles,** 53 Maugus Hill Rd., Wellesley, MA 02181; **Andrew Corry,** P.O. Box 310, Hyannisport, MA 02672

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Okay, guys, I'm looking at maybe three more withdrawals from the 1986 bio book for material about fellow classmates with which to enlighten you. After that, I'll have to either repeat or make up stories about old buddies, which they'll have to retract and from which I'll extract the *real* truth.

Anyway, I can start on an upbeat note, based on input through the alumni grapevine about **Dave Hoag,** who did a commendable (really astonishing) job on our class's "vital statistics, predilections, and careers" in the bio book. The Draper Lab honored Dave (and two others) early this year by appointing him senior technical advisor. Dave joined Draper after his release from the Navy in 1946, and has performed wonders in guidance and control of everything from rudimentary missiles to Polaris, Apollo, and lord knows what-all. According to Dave's own bio, he keeps busy "resting on his laurels," which he plans to continue doing after retirement in 1990, when he reaches 65. Dave, you're a real winner!

I'd also like to mention **Ken Davis's** beautiful Christmas card with a picture of Washington Square from his (and wife Ellie's) penthouse (?) on Manhattan's Fifth Avenue. As I've probably said a while ago, having emanated from Swampscott, Mass., and prepping at Phillips, Ken joined our V-12 troop in Course II (and I on the swim team as we paddled our little hearts out along with **Chabot, Buckman,** et al. on those trips to RPI, Bowdoin, etc). Ken went into engineering with General Electric after graduation, only to detour into Business School at Stanford. Then on to IBM as a vice-president, an appointment to assistant secretary of Commerce in 1969, a brief stint with Syntex before switching to investment banking on Wall Street, and later into his own firm. He's involved with just about everything—community, recreation, travel, and professional groups. His retirement, with Ellie, an associate editor of *Family Circle,* was/will be "gradual," with less work and more play.

Can you believe *another* Swampscott/Phillips lad. . . . **John Dudley,** a rare Course VIII physicist, went on to a Ph.D. at University of California, Berkeley (1960), where he married Constance Anderson. John did "independent research" at Aerojet-General for four years before returning to Academe in 1964 at Colby in Waterville, Maine, where they still reside. Their three children are graduates of Dartmouth, Lamer, and Oberlin.

Have I overlooked **Jim Finney**—one of us V-12 VI'ers? And why? A Greenwich, Conn., stripling, he has plied his trade in "the air pollution control field since graduation," and since 1986 has been vice-chairman of Belco Pollution Control Corp. Jim married Shirley in 1973, with four children on each side, "now spread from Vermont to California." Jim has researched electrostatic precipitators and "traveled extensively in North America, Europe, and Africa." Last heard, he and Shirley were living in Whippany, N.J., with plans to retire "back home" in Greenwich, where he has a boat and some grandchildren. Hope you've made it back, Jim.

Then there's **John Gautraud,** who prepped at St. Albans High, N.Y., and, I guess, fell in a semester behind the July '43 V-12 onslought and ended up in the June '46 group as a bona fide VI'er. His succinct bio shows him spending 10 years in our MIT Instrumentation Lab (with Dave Hoag?), followed by six years with Auco Systems and one year at NASA as director of engineering. He doesn't mention that he picked up a VI master's in 1950. But, moving on, he joined United Tech as general manager of Electronic's Systems for five years, finally settling into Northrop's Precision Products Division, where he may still be a vice-president/department manager. He and wife Stephanie have two girls and a boy. Presumably they're alive and well in Waltham, Mass.

I was tickled to read about **Morton (Morty) Goldfarb,** who didn't show up in the yearbook, probably because he did indeed become an M.D. He has spent 43 years in private practice, specializing in urology, and has become director and president of assorted Nassau County (N.Y.) medical centers and societies. Married to Dorothy and living in Massapequa, they have two boys, now doctors, a girl, now a nurse, and another girl, in telecommunications. As of 1986 he planned to practice for several more years, and "retirement geography will depend upon circumstances at the time of retirement." If Morty's listening, I want to thank him for his great sense of humor during our swimteam workouts and even the meets. While we're at it, I should mention another pre-med who escaped the yearbook, another New Yorker, **Malcom Gordon.** He went on to his M.D. at Boston University and psychiatric residency at Beth Israel Hospital, specializing in geriatrics, which he practices in New York City's Cornell Med Center and Stamford, Conn. Somehow he's had time to found and direct the Peace Corps in Puerto Rico and consult in "hospital administration to various entities." Malcom married a Wellesley girl, Mona, with whom he had three boys, one an orthopedic surgeon, one an investment banker, and one an electrical engineer. He decided not to plan retirement—"to help myself and my patients to keep the 'goals' in the Goalden[sic] years! Have a Healthy Retirement!—**Jim Ray,** Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Our information sources really dried up this month—the only input we got was in the form of a long article about **Paul Cook** and Raychem. Paul started Raychem Corp a few years after graduation and the rest, as they say, is history! What history! Raychem was formed with the idea of using radiation chemistry for commercial products and has become a fantastic success story. The company focuses primarily on heat-recoverable plastics, conductive polymers and shape-memory alloys and sells in more than 100 countries. Raychem employs about 10,000 people—approximately half outside the United States—and last year passed the one billion dollar mark in sales. Paul is still chairman and CEO—and very active. Last July he was one of 10 individuals to receive the National Medal for Technology from President Reagan in a White House ceremony.

Message to all classmates—write me so I can write about you.—**Robert E. McBride,** Secretary, 1070 Pilgrim Parkway, Elm Grove, WI 53122

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As class president, I invited the class officers to help plan our class's future activities. **Denny McNear, Bob Sandman, Harold Ottobrini, Milton Slade, George Clifford,** and **Graham Sterling** met with me at George's home. **Peter Saint Germain, Dan Fink, Ken Brock, Malcolm Reed, David Vigoda, Bill Weisz,** and **Bob Hanpeter** sent written comments about the meeting's agenda. We discussed and decided to plan a 43rd reunion in 1991. I will contact the officers of '47 and '49 and ask them to join with us in planning and attending the reunion. We do not feel committed to any particular month of the year but will seek a location that will permit Boston area alumni to drive to the reunion. We agreed that our 45th reunion in 1993 should include being on the Institute campus for Tech Night at the Pops and Technology Day. Following this, we considered flying to an offshore location for a few days.

In October 1989, MIT's football team is planning their homecoming game with Assumption College on October 28. Our class is planning a tailgate picnic before the game. In December, we will have a champagne brunch at Endicott House in Dedham. Also, I plan to write to several classmates who come to Boston during the year, and we will try to schedule some activities to coincide with the dates that they are in Boston.

I plan to send a letter to all classmates reporting these decisions and asking them to write to me if they plan to come to the Alumni/ae Leadership Conference on Saturday, September 23, 1989. If enough classmates are coming, we will schedule a joint class activity to coincide with the conference.

Ann and **Ken Brock** spent a weekend at the Copper Beach Inn in Ivoryton, Conn. The inn was lovely with beautiful antique filled rooms. The dining room was superb— gourmet! Ken noticed *Technology Review* and learned that Eldon Senner, SM, '71 was the

owner with his wife, Sally. . . . **Bill Oard** has retired after nearly 40 years of corporate life. He and his son, David, have opened a commercial printing business. Bill has qualified for a flight instructor certificate. . . . At the U.S. Department of Energy (DOE), **Norm Kreisman** continues the fight to enhance and protect American technology from actions by the Japanese and other countries. His job is focused on supercomputer, semiconductor, and related issues that impact the U.S. technology base, industrial competitiveness, and in this way affect national security. He is a committee member of the president's science advisors. He represents this group of DOE at interagency or government/industry efforts to address technology problems and issues. Norm reports that neither the government nor industry is doing an adequate job in facing the issues of hi-tech competition from abroad. Recently he was asked by a German technology transfer expert, "When is your country going to realize that World War II is not over yet and the Japanese are winning?" His wife, Gloria, recently became director of public relations for Macy's in New York City. Since Norm's job is in Washington, Gloria is commuting back and forth. Gloria survived three mergers as vice-president of sales promotion at Garfield's Department Store in Washington before she joined Macy's. Norm's health has been very good for the past five years after a decade of heavy duty surgery. He missed our 40th Reunion because of a business trip to Tokyo. Norm and Gloria have enjoyed several trips to London and Paris. Their daughter, Polly, Cornell '78, is a TV reporter/producer in Washington, while daughter Jane, Smith '82, teaches school in Atlanta.

Nick Caldwell died last December. Nick and his wife, Polly, had lived in the same house in Marblehead, Mass., for the past 34 years. Nick lived in Marblehead most of his life. After attending Marblehead High, he graduated from Kimball Union Academy in 1942. During World War II, he was a pilot and officer in the Air Force. Nick was a sales excutive and past president and secretary of Wigglesworth Machinery Co. in East Boston. They were dealers in used machinery. Nick was a member of Tedesco Country Club and Eastern Yacht Club, a past president of the North Shore Children's Hospital, and a member of the Bay State Seniors Golf Association. He was a member of the Church of Holy Name, Episcopal, in Swampscott and a seven-year member of its vestry. On behalf of our classmates, I extend our sympathy to the family and friends of Nick.

Wally Kinnan majored in industrial engineering at Ohio State in 1937-1941. He earned tuition playing trumpet with Jimmy Dorsey, Charlie Barnet, and others. During the war, he piloted Flying Fortress Bombers: was shot down and captured by Germans and spent two years as a prisoner-of-war in Germany. While in POW camp. he took an active part in counter-intelligence activities and organized a successful orchestra for entertainment of fellow prisoners. He later received War Department commendations for both activities. He received the Purple Heart and the Air Medal. The Air Force sponsored his work at MIT and after graduation, he resumed active duty as a weather officer with the rank of captain. Wally began TV weather forecasting in 1953. As a pioneer in the professional approach to weathercasting, he became active in the American Meteorological Society as a spokesman. He was appointed to their board for weathercasting which established the criteria for the now-familiar AMS Seal of Approval for weather presentations. He was awarded the AMS Seal No. 3 in recognition of his work. In 1957, he joined NBC-TV at their Philadelphia station, and in 1965 he transferred to NBC's Cleveland station. After a period of retirement, he joined ABC in Tampa, Fla. He served as instructor, guest lecturer, consultant for colleges and government organizations. In 1987, he was honored by being named a fellow of the American Meteorological Society. Wally and Marjorie, his wife, were married in 1942 shortly before he completed pilot training and went overseas as a combat pilot. One of their sons is a career fighter pilot, and the other son is an attorney.

Gwen and **Lou Kreek** moved to Akron, Ohio, in 1985. He joined a firm that specializes in intellectual property law. Lou was elected president of the MIT Club of Northern Ohio. He also serves on the Alumni Association's National Selection Committee continuing his practice of serving on major committees of the association. Lou has no plans for retirement. His firm has no compulsory retirement age. Gwen continues active in girl scouts and Wellesley alumnae activities. She is vice-president of the Western Reserve Girl Scout Council and is president of the Akron Wellesley Club.

George Keller retired in January from the job of chairman and CEO of Chevron Corp. in San Francisco. He relinquished that role in a planned transition of corporate senior management announced earlier. He worked for Chevron for 40 years and held the top position for more than seven years. George will continue as a member of the board of directors, but he will not have any responsibilities of a day-to-day operating nature. He has been active in several business and charitable organizations in San Francisco, and he plans to continue these activities. George was recently elected to the board of directors of the Metropolitan Life Insurance Co. Chevron permanently endowed a graduate fellowship in chemical engineering at MIT. The fellowship will be known as the George M. Keller Graduate Fellowship. The fellowship was funded by a grant of $350,000 to MIT.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, RI 02806

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Following his recent appointment as dean of engineering at the University of Texas in Austin, **Herbert Woodson** has stepped down as director of their Center for Energy Studies. The center was organized by Herb 15 years ago at the request of the governor and the university president in response to the Arab Oil embargo. Under Herb's direction, it has become an organization with full-time researchers, a faculty of about three dozen, and twice that number of students. Herb will continue to assist the center as a researcher.

Stating that "in my 33 years on the faculty of MIT, I never walked into a lecture hall on such a sad topic," **Amar Bose** provided a two-hour exposition on why he believes that the anticipated major improvement in FM stereo radio called FMX is a failure. Amar defied some legal threats in presenting his findings on FMX at a session at MIT this past January. Amar is, of course, the highly respected founder of the Framingham, Mass., corporation that bears his name and is also a professor of electrical engineering and computer science at the Institute.

As one of the most highly regarded technical experts at the Draper Laboratory, **Milt Trageser** was recently appointed as a senior technical advisor to their executive vice-president. Milt has been with the Draper Laboratory for 38 years. His career has spanned the Thor missile guidance system, the Mars probe, and heading the guidance and navigation system for the Apollo program. He received the Thurlow award for his invention of the floated gravity gradiometer that maps anomalies in the earth's gravitational field. He holds numerous patents on inertial and optical instrumentation.

Ending on a sad note, I have to report of the passing of one of our classmates, **Franklin C. Horlebein** in October 1988 after a lengthy illness of brain cancer. Our condolences are extended to his wife, Martha.—**Martin N. Greenfield,** Secretary, 25 Darrell Dr., Randolph, MA 02368

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Raymond Yong, director of the Geotechnical Research Centre at McGill University, was co-winner of the Charles B. Dudley Award given by ASTM last January in Orlando, Fla. The press release from which I learned this news says he received the award at ceremonies hosted by Committee D-18 on Soil and Rock. One imagines it must have been quite a party. The real prize might seem to be an excuse to be in Florida instead of Quebec in January, but none may have been needed. According to the release, he is also William Scott Professor of Civil Engineering and Applied Mechanics at the University of Florida. Somehow I cannot believe he works in Montreal in the winter and Gainesville in the summer. Yong is a native of Singapore, and has earned degrees from Washington and Jefferson College, MIT, Purdue, and McGill. He received the Dudley Award for co-editing an ASTM publication on testing consolidation of soils.

The spring news drought makes me grateful to **Art Freeman** of Northwestern, who each year is co-author of an unbelievable number of contributed papers at the March meeting of the American Physical Society. This year there were 14 abstracts on work done in collaboration with scientists from Europe, America, and Asia, describing calculations of the electronic and other properties of crystalline compounds. The methods used have unlikely names like "full potential linear augmented wave" (FLAPW), and "linearized muffin tin orbital" (LMTO). I expect, and hope, that

Art's computer is now working on next year's crop of papers.—**Richard F. Lacey,** Secretary, 2340 Cowper St., Palo Alto, CA 94301

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By the time you read this, our 35th Reunion will have come and gone. We'll pass on all the gossip from that party in later issues. In the meantime, we are still trying to catch up with the news that has accumulated over the winter.

Dick Morley, who is credited with inventing the programmable logic controller in 1969, has been named consultant and scientific advisor to MODICON, Inc., of North Andover, Mass. Dick was involved in the founding of MODICON in the 1960s. During the intervening two decades, he has participated in the start up of more than 20 innovative, high technology companies in the areas of electronic controls and industrial automation. . . . **Sam Losh** writes from Pasadena, Calif., that he took early retirement from Xerox two years ago and began working for Datamatrics. But he got tired of the full-time drag, and now has become a part-time consultant for the latter firm. He fills in his time representing Paul Gray at university presidential installations and traveling to the Antarctic with his wife. His daughter Liz has graduated from Harvard and his son Steve is studying at Berkeley.

Dave Wiesen sends word from Newark, N.J., that he and his wife spend a lot of time visiting Newarks as representatives of the International Association of Newarks, founded by Muriel back in 1977. They have been to Newark-on-Trent in England, and other Newarks in Ohio, Vermont and Queensland. Otherwise, he spends his time as a management/engineering consultant, secretary of the MIT Club of Northern New Jersey, and having his knee operated on (because of an accident in Vermont). . . . **Joe Bova** sent a note to **Bob Warshawer,** lamenting the fact that living on the Island of Borneo has caused him to lose touch with the class. He invites calls from classmates who happen to be in Singapore or Borneo. If you are headed that way, give me a call and I'll give you Joe's phone number. And speaking of Bob Warshawer, our permanent class reunion chairman reports that his son Steve is earning a bit of fame as an ultra-distance runner, having recently won the Leadville Trail 100 Ultramarathon in Colorado.

Finally, we are very sorry to have to report the death, last January, of **Bill Patton.** Bill died of an aneurysm in his home in Portage, Mich. Our sincere sympathy goes to his wife Bridget and their children.—**Edwin G. Eigel, Jr.,** Secretary, 33 Pepperbush Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.,** Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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Our 35th reunion was sneaking up, so last January your class officers recruited me (**Bob Greene**) and **Joe Saliba** to co-chair plans for the gala event. Joining our class president, **Paul Attridge,** Joe, and me for this first brainstorming session were **Stan Amstutz, Ed Ehrlich, Alan Friot, Sam Goldman, Charlie Ladd, Rick Morganthaler, Ted Papastavros, Ash Stocker,** and **Mel Weiner.** Others who said they want to help with the reunion include **Phil Brooks, Gil Davidson, Don Eckhardt, Glen Jackson, Clarence Kemper, Roger MacKay, Roy Salzman, Jim Storey, Denny Shapiro, Bill Sweeney,** and **Al Wechsler**—thus we expect a large, active, and representative committee. Each classmate will be receiving a questionnaire, about the time you read this column, soliciting your preference/ranking of a few different formats we are kicking around. Reunions can be great fun if lots of classmates come. We are looking for a splendid turnout for the 35th. More later.

Bill Deibel reports that last July he accompanied daughter Marjory on a University of Washington instigated trip to meet with the Hungarian ministry of finance as part of her credits toward a master of professional accounting. On December, he celebrated the 10th anniversary of his truck dealership—GMC, UD, Western Star.

The Detroit News ran a fascinating story last November about **Stefan Habsburg,** a royal member of our class. Habsburg, a retired General Motors executive, is the eldest son of Princess Ileana of Romania and Archduke Anton of Austria, the grandson of Queen Marie and King Ferdinand of Romania, the great-great-grandson of Queen Victoria of England and the great-great-great-grandson of Czar Nicholas II of Russia. When Austria was bombed by the Allies in World War II, the family left Castle Sonnberg in Austria for Romania's Castle Bran, where cousin Michael I was king. After the war, Romania was under Russian occupation, and Michael I was forced to abdicate. Guards checked to make sure they didn't pack anything except clothes and sealed the latches on their suitcases. Habsburg and his father pulled the pins out of the hinges on the suitcases and slid in the silver and his mother's diamond-and-sapphire tiara which ultimately was sold when they relocated to Newton, Mass. Habsburg got a scholarship to a high school in Pennsylvania in 1949 and went on to MIT. In 1961, he renounced all titles and claims to royal thrones and became a U.S. citizen.

He married his wife, Jerrine, in 1954, and they had five children. He became a chief designer of the research studio at General Motors and helped to oversee the creation of the Firebird II and III gas turbines. In 1959, he contracted viral encephalitis, an inflammation of the brain that destroyed his short-term memory. He would forget that he had children, and needed a map to drive to work and home. He was moved to less demanding jobs. He enrolled in a night business class at Wayne State University to see if he could pass. He got a B and went on to get his master's in 1972. He worked back up to director of educational relations for the design staff before he retired last year. The children are grown and he and his wife bought a cottage in Northport. His short-term memory hasn't returned, but he has learned to take notes and to compensate.

John Lindenlaud began his year by sending a package of material describing what he and Debby are doing in Indiana, where he has been on the faculty of Purdue University's Electrical Engineering School since finishing his Ph.D. there in 1961. I hope this encourages more of you to make a New Year's resolution to do the same!

John has been the recipient of a long list of awards over his career including the 1988 Chester F. Carlson Award from the American Society of Engineering Education for his innovative contributions to engineering education—specifically for his application of instructional technology to undergraduate engineering education and extended impact through papers, conference presentation and work with ASEE and the IEEE Education Society. In 1977, he founded the Purdue Center for Instructional Development in Engineering, an NSF-funded program which he directed until 1981. He has also created a television program, "Exploring Academic Careers," to encourage students to pursue academic careers. From a copy of his Christmas letter, I can report that their second grandchild, Kathy Ann, was born in March and that Debby's polio leg rebelled, requiring much rest, but was improving as of last report.

On a sad note, I am sorry to report that another one of our classmates, **Daniel D. Rothenberger, Jr.** of Marlborough, Mass., passed away on February 13, 1987.

You will note the Greenes have a new address listed below. Edie and I made our long-dreamed-of move on February 1 from our nine-room Colonel in Sherborn to a lovely two-bedroom apartment at 100 Memorial Drive on the MIT campus, overlooking the Charles River. The Sherborn homestead is currently for sale. Our plan is to replace it with a house on the Cape (Orleans area) that we can use as a weekend retreat/summer house/retirement home. We love being city dwellers again and appreciate the roughly two hours a day saved by not commuting. More time now for theater, cultural events, and dinners out with friends (and of course some work), all of which we greatly enjoy.

Keep the news coming.—**Robert P. Greene,** Co-secretary, 100 Memorial Dr., Apt. 11-2A, Cambridge, MA 02142; **DuWayne J. Peterson, Jr.,** Co-secretary, 201 E. 79th St., New York, NY 10021

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Some time last year some of us filled out a form for info from the Alumni Association. Some of these have found their way through to us. **Stanley Turner Wray** lists hobbies as photography and traveling (Yosemite). . . . **Stephen A. Wyers** writes that they are involved in golf, sailboat racing, and skiing. Stephen has been doing fairly well in the local sailing club bi-weekly race; although he hasn't hit the national events, he hopes to make the Lightning districts this summer. Has been skiing at Snowbird with his daughter, Becky, and Dad (77 years-old) for the past several years. Stephen is working on the X-30 (National Aerospace Plan) which proves an interesting challenge. "We" at McDonnell have high hopes of winning the contract. . . . **Bruce Daniels Wedlock** served as chairman of the Board of Electro/88—the largest electronic convention in the East—held in Boston. Bruce is active in Masonry and is past-master of MIT's Richard C. MacLaurin Lodge (in 1984) and presently master of Hiram Lodge, Arlington, Mass. . . . **Christian Karel Van Peski** writes that the family enjoys horseback riding and goes camping with the horses for a three or four-day weekend once a month. It's a good way to see some of the country not otherwise available, and also to meet interesting people.

We lost two classmates: **John Patierno** died of cancer on February 25 of this year. John was one of America's most respected leaders in advanced aeronautical design, development, systems, and manufacturing; and was credited for the "forgiving" reputation, by pilots, of the handling of Northrup aircraft. He served as corporate vice-president and general manager of the Northrop's B-2 Division (about 12,000 employees), having previously led a small team on the low-observable or "stealth" technology that makes the B-2 hard to detect, and has been called the "father" of the B-2, which in turn has been referred to as the bomber of the future. In his 33-year career he is credited with having played a major roll in the design of every aircraft produced by Northrop, starting with his first project on the USAF T-38. A native of Clifton, N.J., John received an MS in aeronautical engineering from University of Southern California after graduating with us. Earlier this year, Patierno was presented with the Reed Aeronautics Award, the highest honor granted by the American Institute of Aeronautics and Astronautics. He resided at 17 Hermitage Lane, Newport Beach, Calif., and is survived by his wife, Jean Rose; four children; sister; mother and stepfather. (A note of thanks to **Dick Feingold,** Class Secretary Emeritus, for this information.) . . . **Daniel Schurtz**'s body was found frozen on a section of the Appalachian Trail in New Hampshire eight days after leaving his residence in Jamaica Plain, Mass., on December 2nd for "his morning walk." Dan enjoyed hiking and rugby and was an accomplished pianist. His ashes were sprinkled in one of Dan's favorite hiking areas in California. His survivors include his aunt, Ruth Schurtz, of Santa Barbara, Calif.

Maybe we can take a little time for remembrances of our associations. Take good care.—**George H. Brattin,** Secretary, 39 Bartlet St., Andover, MA 01810, (508) 470-2730; **Irwin C. Gross,** Assistant Secretary, Sweets McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

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In April, we promised that some reunion "stats" would be forthcoming. Here they are at last. These statistics were ably prepared by reunion committee members **Dick Rosenthal, Bud Mederios, Ralph Schinzel,** and **Irv Stiglitz.** Responses were received from 212 classmates, representing 25 percent of the total class. On the love and marriage front, we average 1.16 marriages per classmate, which is considerably lower than the national average. And, we have 2.7 children each, again considerably higher than the U.S. average.

Based on the class survey, most of us are extremely happy in our jobs with 38 percent indicating very high job satisfaction and 36 percent high job satisfaction. About 50 percent of us work for large companies having over 1,000 employees; roughly 25 percent of us are in defense related industries. Our 30th reunion class profile contains dozens of other interesting facts including family income levels, weight gain and fitness, alcohol consumption, job responsibilities, and others. Most of the information is displayed in computer graphic format. The profile was sent to all those who paid their class dues. If you would like a copy of the profile, please send me your dues of $20, and I'll send you a copy.

Now for other news. **Bill Hauke** and his wife, Carole, operate Hauke Building Supply in Burlington, Vt. Despite the company's name, they are primarily involved in property management of about 200 apartment units. Also active in the business is one of their sons who handles the commercial rental and sales operations. Carole and Bill have four children between the ages of 17 and 26, three of which are out of college and "one to go." Bill has been very active as a scoutmaster in the Boy Scouts for 30 years. Just prior to the reunion, Bill and Carole returned from a lengthy trip to Australia and New Zealand.

We talked with Bobbi and **Fred Fisher** at length at the reunion. Married since the end of Fred's junior year, they have two sons, both of whom are engineers, one daughter-in-law, and two toy poodles. As hobbies, Fred continues to collect and work on old Jaguars and to participate in model railroading. According to Fred, "I'm a trivia nut and therefore love old movies and my VCR. I even manage to do some oil painting when time allows. At this stage, Bobbi and I frequently take our holidays in the Caribbean."

In a brief note, **Phil Sapp** tells us that "after ten years in Huntsville on the spacelab program, I am returning to Huntington Beach, Calif., to join the space station team in system engineering. Last year marked several anniversaries including 30 years with my company and 26 years of marriage. Our oldest son Paul is a graphics artist at BDM in Huntsville, son Peter just graduated in Biology from UAH, and our daughter Pam is a sophomore at Montevallo."

Among the participants in the Boston Seminar Series for 1988-1989 was **Ken Smith**, vice-president for research at MIT. His topic this spring was "International Competitiveness: Problems and Opportunities for U.S. University Research." . . . Received in the mail a spiffy brochure from **Paul Rothschild**'s company, Fremont Plastic Products, Inc. This firm produces custom blowmolded products and performs secondary operations including assembly. Paul's wife, Rona, is active in the business and she notes: "The company is growing rapidly. We have been very lucky. We enjoyed reliving the big 30th through your articles in the *Tech Review.* A good time was had by all." By the way, if you want to see what a really good black-and-white brochure looks like, give them a call. . . . **Sander Weinreb** reports that he is now on leave-of-absence and teaching microwaves at the University of Virginia. He and Marjorie have two children, including their son Glen, who is in the MIT class of '86, and a daughter, Ellen.

Nina and **Allan Rodolitz** sent a note: "Both of us are extremely involved in Jewish cultural, religious, and philanthropic activities. I am serving part-time in several fund raising positions in the UJA-Federation of Greater New York, while Nina serves almost full-time with this organization and specializes in the problems of teenagers and substance abuse. Recently, I have become involved with the American Israel Public Affairs Committee and several political action committees. In my spare time, I relax with bicycle riding, golf, and tennis. We travel extensively and have enjoyed leading several study missions to Israel."

Bob Parente was at the reunion and said that his consulting practice continues to specialize mostly in electric utility power supply. His recent projects have included one with Consolidated Edison in New York City, and he is now working on a project to help the British Government regarding plans for their electric utilities. Bob and Rozalinda, a former RN from Hawaii, have three children, and they are living in Santa Monica. Among Bob's interesting activities are his duties as a volunteer deputy sheriff in Los Angeles County. He donates one eight-hour shift per week in uniform, in a patrol car. . . . Keep your cards and letters coming. See you next month.—**Mike Brose,** Secretary, 841 Magdeline Dr., Madison, WI 53704

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By the time you all read this, you should be decompressing from the fabulous 30th reunion held at The Ocean Edge in Brewster. **Dave Packer** and his hard working committee should be given heartfelt congratulations for a job very well done.

Dick Krock says that he was a practicing researcher and supervisor of metals research until 1980 when he left the sciences (hmmm. . .sounds very familiar) to embark on a career in business where he is now a major owner and chairman/president of University Bank and Trust, a National Commercial Bank located in Newton, Mass. . . . **Marie Wray** in her response to info for the new alumni register writes that her hobbies include photography, traveling, cake decorating, sewing, and gardening.

Barrie Shabel has been living in Murrysville (near Pittsburgh) since 1966 when he joined Alcoa. He was active in the Jaycees and fencing for several years but dropped out of those activities about ten years ago. His research at Alcoa has been in the area of physical and mechanical metallurgy. One of his more significant honors was to be selected a co-recipient of an IR-100 Award (1977) for the development of aluminum auto body sheet alloys. His daughter is attending the University of Pittsburgh with an eye on attending law school. Barrie's wife keeps busy running their business, The Gold Bug, which specializes in jewelry with cat designs.

Ken Taber writes that he has gone full circle since graduation by rejoining a company involved with pure beryllium research. (Thank goodness for my fellow Course IIIers, or we wouldn't have a column.) Ken does a bit of teaching through the Center for Professional Advancement as well as doing limited independent consulting. . . . A recent company press release announces the appointment of **Andrew DeStena** as vice-president and general manager of Lummus Crest's Houston office. Lummus Crest is a subsidiary of Combustion Engineering Inc. Andrew had previously been chairman, president, and CEO of Forney Engineering Co. in Dallas, a wholly-owned subsidiary of Foster Wheeler Corp. The release goes on to say that he has had extensive international experience serving as director of affiliate operations in Japan, Holland, Italy, Mexico, and Spain.

Adul Pinsuvana's second son graduated from WPI last December with a degree in mechanical engineering. Adul bemoans the fact that he has now paid in full for three children to attend U.S. universities which has "cost me more than half my fortune!"

Bob Polutchko's son Bob Jr. will be graduating again from the Institute with his S.M. in Course XVI. Daughter Carol also graduates this year from Colorado State. Daughter Diane made it out of Boston College two years ago, and youngest daughter Karla is an engineering sophomore at Tufts. Bob goes on to relate that with the enormous negative cash flow from all this, he's happy to report that Martin Marietta Corp. has elected him a senior vice-president and president of the Information Systems Group. He closes by saying, "Not bad for an aerodynamicist—but then again, we take work where we can."

The final item in this month's notes relates to the Class of '59 Student Aid Fund set up at our 25th reunion. Pat Carroll from the Financial Aid Office wrote to tell **Bob Muh** that this year we were able to assist six students, three of whom were helped last year. Since there were not children of '59ers with financial need this year, three freshman who are children of alumni from other classes were selected. One in particular, Geoffrey Mobisson from Enugu, Nigeria, whose father graduated in the class of '69, is particularly interesting. In addition to his studies as an electrical engineering major, Geoffrey was a varsity member of the basketball team, is athletic director for his fraternity, helped organize two on-campus blood drives, and is a member of the Boston Computer Society. Sounds like a very worthy recipient of our support. Pat goes on to thank the entire class for the spirit of generosity which makes their job more rewarding.

On behalf of Ron and myself, I would like to say that the past five years were enjoyable, and we hope you found reading our notes as much fun as we gathered in the writing. We are confident that whoever is chosen at the reunion to carry on for the next five years will continue to get the support from all of you that you gave us. Again, thanks for the opportunity.—**Art Collias** and **Ron Stone,** Co-Secretaries Emeriti, 24 Hemlock Dr., Canton, MA 02021; 116 Highgate Place, Ithaca, NY 14850

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In a press release emblazoned "Big Bold Wolf Has Come To Town," the architectural-engineering firm of Ellerbe Becket announced that **Harry Wolf** has joined its Los Angeles office as senior vice-president and design principal. Harry, a four-time national AIA Honor Award winner, was head of his own New York firm, Wolf Associates, for 23 years before joining Ellerbe Becket. . . . **Daniel Whitney,** a technical staff member of the Charles Stark Draper Laboratory, was recently named a Fellow of the American Society of Mechanical Engineers. Dan has been with Draper Lab since 1974, and has made numerous contributions to robotics and their application to industrial assembly. Incidentally, Dan really made a lasting impression on his first PhD student, as it was he who nominated Dan for the fellowship.

In a short note, **William Nicholson** wrote that he has been with the Potlatch Corp. in San Francisco for the past 18 years and is currently their manager for corporate energy services. Bill also said that he thoroughly enjoyed the Course X Centennial celebrations (your secretary, unfortunately, missed it). . . . Finally, I recently got a phone call from **Jorge Rodriguez** who said that he was soon meeting with **Tim Hart** to start planning for the 30th (!) Reunion. As you might expect, details are not firm, but Jorge said we should all pencil in the first full week of June 1990 for our get-together. . . .Let me hear from you soon. At least put a short note on the card when you make your contribution to the Alumni Fund (hint).—**Frank A. Tapparo,** Secretary/Class Agent, 15 S. Montague St., Arlington, VA 22204

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The MIT Office of Student Financial Aid has informed us that the MIT Class of 1962 Scholars for

1989 are Kenneth Havlinek, a senior in mechanical engineering, and Rachel Harmon, a junior in civil engineering. We thought the class might want to know about the scholarship assistance provided by our class gifts, and I think we can be justly proud of these two MIT students who are designated as the beneficiaries of our financial assistance. Kenneth was a '62 Scholar last year, continues to maintain an outstanding academic record in Course II, is active in his social fraternity and plays intramural basketball, volleyball and softball. Rachel is a junior in Course I from Valley Stream, N.Y., and in addition to an outstanding academic record, is captain of the varsity diving team, an associate advisor, and is active in UROP, the Undergraduate Research Opportunities Program.

I received a nice letter from **Jerry Adams** who moved in 1985 with his wife Karen and three daughters from Salem, Va., to Columbia, Md. He is now a financial consultant with Merrill Lynch. Jerry says that is quite different from teaching physics in college for 18 years. Karen works with a video production company. Alaina, their oldest, graduated from Oberlin in May 1988 and lives at home while working as a CPA. Second daughter Alicia attends Wooster College in Ohio and third daughter Lori is in the ninth grade in Columbia, Md.

Jerry writes that classmate **Robert Swaney** and his family from Ventura, Calif., came east for a visit in the summer of 1988, and they had fun talking over old times and new happenings since their last get-together at the 5th class of 1962 reunion in 1967.

Jerry still corresponds with **Art Funkhouser** in Bern, Switzerland. In addition to his work as a Jungian psychoanalyst, helping people to interpret their dreams (and travelling around the world giving talks on deja vu and other ESP topics), Funky is also doing scientific programming and scientific translating.

Jerry also notes that "the most important change in my life is that I have come to believe in the crucial importance of tolerance for other people's beliefs. I certainly didn't have this while I was at MIT, but people do change. I think it is dangerous for anyone to think they have a corner on the truth. The prevalence of 'holy' books in the world seems to foster an authoritarian viewpoint by many. These texts are sometimes used to defend our own, sometimes indefensible, positions. We all have to remember that these 'holy' books were written by persons, and they are 'holy' only because we bestow that term on them. Maybe we all have a little bit of truth and we need to listen to each other to get bigger bytes. Here's hoping we can all 'sleep cold forever in the draft of an open mind.'" While Jerry's comments might not be highly popular in Iran or on the PTL network, I felt his words of advice were worth passing on to our classmates.

If other members of our class would like to pass on individual insights or personal words of wisdom based on their experiences pre-, at, or post-MIT, we would be happy to consider them for inclusion in our '62 class notes.—**Hank McCarl,** Secretary, P.O. Box 352, Birmingham, AL 35201-0352

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OK, guys and gals, this is getting serious. The mailbag was thin for the last issue, and it's thinner this time. It's going to cost you. So next time I expect to see reports, news, mail, accounts, bulletins, dispatches, narratives, descriptions, anecdotes, etc. Understand? Now here is the news I did receive.

I got a nice letter from **Woody Bowman.** As you will remember, Woody has been a state representative in Illinois for about a dozen years. He is now running for state comptroller. Naturally we wish him well. The election is in the fall of 1990, but now is the time to put together the forces it will take to be nominated, and then to win the general election. Let Woody tell it: "My first objective is to obtain the endorsement of the Democratic Party. The party is so fractured that this will not be easy. For you game-theorists there exists a dominant strategy to my zero-sum problem: I must amass enough support to win a primary election in the event I am not endorsed. If I do this, I will probably be endorsed." See, politics is real easy to understand.

The only other news is my own, and a fair bit of it. (That's how you classmates pay for not writing—you get to read me babbling on about myself.) I am proud to say that my son Gary has been offered admission to the graduate school in the Department of Brain and Cognitive Sciences at MIT. As of this writing he says he is 98 percent likely to accept (the other choice being Carnegie-Mellon). My daughter Julie (born last August) is doing really well. She keeps her aplomb under almost all circumstances, eats well, and is big and strong. And she loves her mommy and daddy. What more could a person want? The new company Linda and I set up, called Training To Go, is prospering. Linda, who has been training (under a different company name) some five years has to turn down work. After some nine weeks (at this writing), I have signed up to do end-user training (under sub-contract) for a national PC software publisher and a regional systems integrator, and expect to sign up another regional integrator in a couple of weeks. I also train a steady stream of end-users on standard PC packages. I am definitely glad I finally turned entrepreneur. Don't forget to write or phone with *your* news.—**Phil Marcus,** Secretary 3410 Orange Grove Crt., Ellicott City, MD 21043, (301) 750-0184

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Summer greetings to all! I hope that many of you will have been able to attend our 25th reunion. Future columns will include news from as many of the attendees as I could track down. For now, I'll dip into the nearly empty envelope of notes and news items.

Dave Spencer, who notes that he is only semi-officially in the class of '64 (having spent the majority of his undergraduate career with the class of '62), climaxed his entrepreneurial efforts of the past six years with a sale (of his company?) to Dupont/Xerox and ECRM. In Dave's words, "However, wealth still eludes me. . . . maybe next time." His wife Pam is well, Scott is a high school sophomore, and Marc has completed his freshman year at University of Rochester studying electrical engineering.

George Harlem is in his 14th year with Codex Corp., a subsidiary of Motorola in Canton, Mass. He is senior director, International Marketing Operations, managing the group responsible for tactical marketing support to Codex's worldwide, 45-country sales organization. (One must ask: Does this make George Harlem a Globetrotter?) George's wife, Rosina, is a real estate broker in Acton, where the Harlems live. Daughter Jennifer has finished her sophomore year at Brandeis, and daughter Michele will be a high school senior.

As the address below indicates, Louise and I have returned to New England. We're living in a 199-year-old house on eight acres overlooking the Connecticut River, about 20 minutes north of Hanover, N.H. After nearly 22 years with TASC, I have made the transition to a somewhat less structured professional life. I intend to do some engineering management consulting with a possible future academic connection. Over the short-term, the vegetable garden and the golf game will get some serious attention.

If you weren't able to be at the reunion, please send me your news so that I can share it with our classmates.—**Joe Kasper,** Secretary, RR 1, Box 181, Lyme, NH 03768

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You're probably wondering—"Steve said he was going to the Harvard Business School, no columns 'til August. What's he doing back in July?" It turns out that we get a long weekend twice during the program—think of it as a furlough or parole—and this one happened to coincide with the copy deadline for July. So here I am.

My membership in the IEEE Computer Society gets me the IEEE Boston chapter's monthly magazine, so I found out a few weeks ago that **John Kassakian,** still a professor of electrical engineering at the Institute, has been elected a fellow of the IEEE. John's research has been in the area of power electronics and on energy conversion and control using power semiconductor devices. John's received various awards over the years including an IEEE Centennial Medal in 1984 and the IEEE William E. Newell Award for outstanding Achievement in power electronics in 1987. . . . **Chris Ebbe** sent a letter in early January in response to the reported dearth of material for the column. He reports that he's been involved lately in training mental health professionals in the American Psychiatric Association's new diagnostic system, doing five training sessions over the last year for institutions or on his own. Chris is psychology training coordinator for the San Bernardino County Department of Mental Health. . . . In more medical news from California, **Arnold Abrams** wrote to say that last October he was appointed chief of pathology and director of Laboratories for Saint John's Hospital and Health Center in Santa Monica.

Walter Miller, yet another California doctor, is professor of Pediatrics at the University of California, San Francisco, concentrating most of his time on research. His laboratory is studying the molecular biology of steroid hormone synthesis by cloning the genes of the various enzymes involved. This work led to his receipt of the 1988 Edwin B. Astwood award from the Endocrine Society. Walt says the work is almost (but not quite) as much fun as playing with his 3-year-old daughter Samantha. . . . **Ed Hoffer,** another physician and a Wellesley neighbor, writes that he's "still too busy" with a full time private practice in cardiology and internal medicine, a half-time research position at the Massachusetts General Hospital computer lab, and a position as head of pre-hospital training for the town of Framingham. At the time he wrote, Ed was recovering from a bike accident and hoping for snow and cross-country skiing. I'm writing in late March, so I can put in a footnote that it was a snowless winter. We missed the skiing too, Ed.

Continuing with "medical month," **Herb Mower** writes that he's the senior radiation physicist at the Danbury (Conn.) Hospital. Herb is also active in youth work including directing a youth handbell choir, serving as a Girl Scout and YMCA camp volunteer, and serving on the housing corporation for Sigma Chi at MIT and Western Connecticut State University. Herb's also serving as an MIT educational counselor. . . . Back in California, **Bob Waymost** writes that in June of 1982 he married Catherine Marchette, a former "Cliffie" whom he met in Los Angeles. Cathy and Bob have a 5-year-old son, Matthew, of whom they're naturally very proud. Continuing the month's medical theme, Bob practices pulmonary and critical care medicine in Los Angeles.

On to the non-medical component of the month's news. **Charles "Chico" Gholz** writes that his son Eugene is a freshman at MIT, taking mostly sophomore courses (including chemical thermodynamics) and doing very well. He is participating in the debate team which is "a great time sink but has him doing a lot of interesting traveling." Chico says he's looking forward to seeing us at the 25th reunion next June. . . . World traveler **Tom Callahan** writes that he's running two companies in Thailand, Thailand Technical Services and Thaitronic, doing communications, computers, and energy management. Tom and wife Meo have a daughter, Kay, and a son, Tommy. . . . Closer to (my) home, Joan and **Cary Shaw** sent a copy of their Christmas letter, including notes about travel and canoeing. Cary is

A Chemist Goes to Congress

To Representative Bruce A. Morrison, '65, (D-Conn.) of New Haven there is no conflict between principle and experience. "You have to remember," he told an MIT student audience during this year's Independent Activities Period (IAP), "your constituents sent you to Congress to do what you think is right."

Morrison is a chemist turned lawyer, and he brings to his seat in the U.S. Congress strong principles supported by skills that draw on both his professions—analytical ability, organizational skills, and a sense of strategic planning. He spoke at MIT at the invitation of the Office of Career Services, appearing in a series on how an MIT education can relate to "alternative" as well as "mainline" careers.

Morrison enrolled in MIT in 1961, he said, after graduating from a high-school science program energized by the Soviet launch of Sputnik and the U.S. space program designed to respond. But he soon found himself leading two lives, one in the chemistry laboratories and another in Senior House, where as president he was involved in lots of "human questions."

Later, as a graduate student at the University of Illinois during the years of campus unrest, these two lives really came into conflict. And his choice turned out to be more politics than the laboratory. "The loneliness of the laboratory didn't measure up to the pleasure of working with people."

Though Morrison persevered for his doctorate in chemistry, his next step was a degree from the Yale Law School in 1973. There he quickly confirmed an interest in public service that led to his successful 1982 bid for a seat in Congress.

"The most important thing about my career decisions," Morrison said, "has been learning not to be governed by what people expect but by what I am pleased to do and gives me pride:" solving the problems that interest him.

But what happens, asked a student, when a constituent asks you to vote for something you don't believe in?

That depends on the issue, said Morrison. On some questions—the death penalty, abortion, and Contra aid are examples—Morrison has a personal commitment that is absolute. His constituents knew those when he was elected, and his policy is "disclosure"—to tell the voters what he believes and how he has acted on those beliefs.

At the other end of the scale are issues of local significance, where constituents and communities have specific needs and priorities. Morrison tries to serve those priorities.

In between is a gray area. Here, he relies on principle. "I was not sent to Congress to take a plebiscite before every vote. I have to make decisions, do what I think is right, and stand for those decisions when the next election comes." So far, Morrison's constituents have liked what they've seen. He has been regularly reelected since his upset victory in 1982.—*John Mattill* □

manager of Corporate Management Science at Pitney Bowes in Norwalk, Conn. . . . Finally, a press clipping reveals that **Bruce Morrison** is one of seven MIT alumni who were reelected to Congress last November.

About Harvard: the Program for Management Development is a very intensive three-month program for middle managers who either received MBAs immediately after undergraduate school or who, like me, have never had formal management education. The curriculum is probably similar to the Harvard MBA program in content but much compressed and tailored for mid-career managers. One of the faculty is Professor John Kotter, a member of the MIT class of 1968, who teaches a very thought-provoking course on leadership and management style. For someone like me, whose last experience of formal education was an SM in civil engineering at MIT in the 60s, the two biggest differences are the very international character of the subject matter and student body, and the lack of "right answers" in courses taught by the Harvard Business School's case study method.

Continuing with an update on my own doings, shortly before the end of last year, I was appointed to the Computer System Security and Privacy Advisory Board established by the Computer Security Act of 1987. The board's role is to advise the federal government on technical and policy issues pertaining to the security of government computer systems. A fellow member of the board characterized such work as "electropolitical engineering." Not a bad description. Back with more news when Harvard's done.—**Steve Lipner,** Secretary, 6 Midland Rd., Wellesley, MA 02181

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I am sorry to report that one of our classmates, **Tomas van Tienhoven,** was a passenger on Pan Am flight 103 when it exploded over Lockerbie, Scotland, on December 21, 1988. Tom was vice-president of Sheraton Management Corp., developing hotels across Europe, Africa, the Indian Ocean, and Pakistan. He had recently been traveling in South America as well. He leaves his wife, Vera, his son Cristian, who is planning to attend MIT, his daughter Saskia, his mother, and two brothers. He will be missed.

More news next time.—**Jeff Kenton,** Secretary, 7 Hill Top Rd., Weston, MA 02193

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We can thank **Bob Howard** for all the news this month. Bob and I enjoyed a fine dinner together during his recent trip to the San Francisco Bay area, and he took the opportunity to update me on his activities as well as those of two classmates. Bob remains incredibly busy with a few companies he has founded. In addition to his activities with First Communications, a microwave communications company founded in 1982, Bob is a founder of Peregrin Group, an investment banking firm that handles acquisitions, mergers, LBOs, and oil and gas limited partnerships.

Bob and **John Sussman,** who lives in north Miami, recently reestablished the MIT Club of Miami. John is in charge of local area networks for manufacturing for Racal-Milgo, a large English electronics company. He is the soccer coach for his son's team, and his oldest daughter is a freshman at Tufts. Bob observes that John looks no older than he did at MIT—in particular, he has no gray hair or spare tire.

Bob also has kept in touch with **Eric Coe,** who practices medicine in Leesburg, Fla., and still plays tennis. Eric's fourth son was born last August. . . . We wish you all a relaxing summer. Please take a few minutes to call or write.—**Jim Swanson,** Secretary, 878 Hoffman Terr., Los Altos, CA 94022

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I hope these notes make the July issue. I now have a computer and am not yet hooked up to my printer and have lost my typewriter, so my secretary is typing these notes. **Dale (Schain) Krouse** writes: "This is the first time I have written since graduation, so I'll attempt a quick summary of the past 18 years. After receiving two graduate degrees, I worked both in industry (AT&T and E.F. Hutton) and in education, in the United States and abroad. In 1973 I married Lou Krouse, an entrepreneur who is president and CEO of two successful companies. We have two wonderful children; David, 10, and Rachel, 6. We are living in Franklin Lakes, N.J., where I am executive vice-president of National Payments Network, a rapidly growing new company based in Paramus, N.J. Our company uses electronic terminals in local neighborhood stores to provide bill paying and financial services to low income Americans. I have been involved with MIT since graduation—an Educational Counselor since 1975, and I recently was honored by being elected president of the Alumni Club of Northern New Jersey. I have been an officer on the board of several community and school organizations; and, in my "spare" time, I love playing tennis." Editor's Note: Dale's husband is CEO of National Payments Network. Their company has been featured in *Forbes* as well as on national television.

Randolph M. Gregg has been married to Abbie Carlstein Gregg, '74, for 15 years. They have daughters, age 2 and 6 months. He moved from Motorola in Phoenix, Ariz., to their offices in Chandler, Ariz. The Greggs now live in Tempe, Ariz. . . . **Adrian Bejan,** a fellow of the American Society of Mechanical Engineers, won the Gustus L. Larson Memorial Award which was presented at the ASNE's Winter Annual Meeting in Chicago.—**R. Hal Moorman,** Secretary, P.O. Box 1808, Brenham, TX 77833

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Hi! I'm sorry to report that there is not a lot of news for this month. I was in Washington, D.C., in late February and got to see **Becky Donnellan** and her family. The kids are in that real cute and active stage, and between them and work at the Justice Department, she is kept busy. Husband Nat was moving offices.

The mail brought news that **Steven Cahan** has joined the medical staff of Day Kimball Hospital, in Putnam, Conn. He will presumably continue his ophthalmology practice. . . . **Turgay Ozkan** was recruited away from the World Bank to help overhaul the Turkish state banking sector. He is now presiding over the establishment of the Eximbank. . . . That's it for this month's news. I am obviously back from my jaunt overseas, returned just in time for Christmas. **Dick Fletcher** and I want you to send more notes to either of us. I write this just before Easter, and I hope that you had a great one.—**Wendy Elaine Erb,** Secretary, 6001 Pelican Bay Blvd., Apt. 1003, Naples, FL 33963

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Received a few copies from different newspapers of a piece on **Gregory Chisholm.** After a career as a mechanical engineer and instructor at the University of Detroit (and for the last few years seeking a PhD at MIT), he now is in seminary becoming a Jesuit priest. Greg, in fact, is featured in a film by the Society of Jesus promoting the priestly vocation. . . . **Amnon Meyers** is living in Laguna Beach, Calif. working as a senior scientist with McDonnell-Douglas.

A publisher's promotional letter arrived today promoting **Peter Huber**'s new book, *Liability.* It deals with the results of the overemphasis on tort liability in the courts and the effects of a litigous society overpopulated with greedy lawyers. The promo sounded fascinating, so, Peter, if there is an autographed copy lying around. . . . Yesterday (today is St. Patrick's Day) the U.S. pulled all Chilean fruit off the shelves of our nation's grocery stores as a result of a trace of cyanide found in two grapes, coupled with a threat. This has brought the economy of Chile to a standstill. So, just for jollies, I called the office of the Surgeon General in Bethesda, Md., and discovered that 390,000 people a year die from the effects of smoking. Yet you can buy a cigarette in any grocery in the U.S.A. Have we got our priorities on straight or what? Why, pray tell, don't the terrorists threaten to poison a few cigarettes instead of grapes? Just a thought.—**Robert M.O. Sutton, Sr.,** Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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From a registration form for the National Technological University Technology and Management Symposium (do I have sources or what?), I learned that **Charles Tucker III** is an associate professor of mechanical and industrial engineering at the University of Illinois, Urbana Champaign, where he received the Everitt Award for Teaching Excellence. . . . **Loren E. Dessonville** writes, "My wife, Kathy (Neb. '77) was admitted as a partner in the consulting division of Arthur Anderson & Co." . . . I received a birth announcement from **Leonard DeRoma** and wife, Mary. Their first child, a son, was born on January 29, 1989. Michael Leonard DeRoma, young bruiser that he is, weighed in at a healthy 7 pounds, 6 ounces. Warmest congratulations to you both!

Finally, I received a very enjoyable letter from **Michael W. Conner.** He may have expected me to edit it somewhat. But since I have plenty of room (HINT: more of you should be writing), I want to share with you all Michael's 14-year odyssey since leaving the Institute in its entirety:

"When I left MIT I entered veterinary school, a career path followed by a chosen few from MIT. After the four years of purgatory in Georgia, I returned to the Boston area where I spent three years training in comparative and experimental pathology at Harvard Medical School and Children's Hospital. This was followed by two years of training in toxicology back at MIT. In 1984 I became an assistant professor of pathology at Boston University School of Medicine where I continued my collaborative research with MIT investigators on the toxicity of acid aerosols derived from fossil fuel combustion. After four years of doing the classic academic juggling act (teaching, research, generating 100 percent of salary from extramural sources) I felt it was time for a change in venue.

"This last summer (1988) I accepted a position as a pathologist at Smith Kline & French Laboratories in Pennsylvania. I accepted the job in late May and two days later the price of Smith Kline Beckman stock dropped 25 percent. I didn't think that anyone on Wall Street knew I was coming. Well, despite what you might read in the financial sections of the newspaper, SmithKline seems to be doing well enough. It was an interesting experience to go from academia, where there is a continuous undercurrent of concern about employment that is based upon the vagaries of NIH priority scores, to a company in which many people are worried about losing their jobs. It was just like being back at the university. My job was not one of those eliminated during the restructuring so it seems that they still need people like me to develop new drugs.

"Turning to my personal life, I was married following graduation to an MIT employee and we remain married. Barbara and I have one child, Sean, who was born 10 years ago in Georgia during my days as veterinary student and chicken farmer. Sean acquired a passion for playing hockey when we lived in Massachusetts. When we moved to Pennsylvania last summer he tried out for the Philadelphia Little Flyers and made the team. You may recall that this was the team for which Orel Herscheiser of World Series fame played. Maybe my son will also turn to baseball. The Little Flyers is a traveling team in a real serious sense. The closest team that they play is in suburban New York. We just returned home from the season's last tournament in Montreal and I can't recall being home for more than one weekend in a row since September. In all honesty, I'm not sure that I could find a better way to spend my weekends."

Thanks so much for writing. Until next time.—**Jennifer Gordon,** Secretary, c/o Pennie & Edmonds, 1155 Avenue of The Americas, New York, NY 10036; 18 Montgomery Pl., Brooklyn, NY 11215

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Tom Martin has been elected a vice-president at Arthur D. Little. He has been at Little since 1978. He is the director of the artificial intelligence (AI) consulting practice and the manager of the Arthur D. Little Center for Applied Artificial Intelligence. He has specialized in expert system delivery, AI programming languages, and the application of hardware and software tools in business and industry.

Joe Abeles sends a postcard from Paris: "Will be moving to Sarnoff Labs (old RCA Labs) in Princeton, N.J. (Joe was formerly with Bell Labs.) Presently enjoying the spring here in Paris."

Your secretary had a telephone visit with **Bob Lepkowski.** Bob has been a partner at Hancock Venture Partners in Boston for five years, helping supervise a portfolio of over $500 million. He has also been married for five years to Jan Davis. Jan is the owner of a mail-order firm. Between the dual business lives and a son (age 2), they, like we other dual-career couples, are swamped.

Unfortunately, this is all the news we have. My pleas for mail are being ignored. Please spend 10 minutes writing to me with a few details of your lives for the Notes. I am sure you are all doing things that your classmates would enjoy reading about. It is unlikely that each of you remains in contact with all of your friends from the 'Tute. The Notes can provide you with a convenient form of message center if you are all willing to use it. So please avail yourselves of our services and write.

As for your secretary, the markets I analyze and trade remain nervous and jumpy, especially foreign exchange and cocoa. My brother and my PC-based voice recognition product, the Voicebox, and business are coming along with an increase in commercial acceptance of this form of input. I am writing up and beginning to circulate a business plan for the next generation device, which I have tentatively labeled "The Scribe," which will be a dictating typewriter, using as its vocabulary the *Random House Dictionary of the English Language.* (Unfortunately, this is not something I can finance myself.) While an 80386-based PC, it will do from 60 up-to-80 wpm dictation with full verbal word processing and data base management. With Intel's new 80486 chip, we may be able to do virtual speech recognition, i.e. recognize and transcribe speech in real time, without the speaker having to slow down. I find it very exciting to be on the edge of a major new PC-based technology. If any of you are interested in this area, please feel free to write or call. At home, in my bountiful free time, I have been teaching my daughter (age 3) some of the fine points of flower gardening. The net result of all of this activity is that an amazing amount of time has passed very rapidly.

Please write, fax, or call. We need news.—**Arthur J. Carp,** Secretary, 254 West 35th St., New York, NY 10001, (212) 736-1960, Fax: (212) 736-3664

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We have news of classmates primarily on the coasts this month. **Bob Jacobson** is in Palo Alto, back in graduate school. He writes that he has only five years to go. In between lab work, Bob is enjoying his baby daughter Katherine. . . . **Sue Kayton** writes us from Los Angeles: "After years of playing the TV game show *Jeopardy* in my living room, I decided to try the real McCoy. The segment on which I made a fool of myself airs July 4th. I am now the proud owner of a case of Lee Press-On Nails, and six months' worth of dog food (but I don't have a dog.) Now that I know what not to do, maybe I'll try again next year."

Your class secretary and wife **Diane Curtis** were in San Diego for the San Diego Crew Classic and met up with **Dave Wiederspahn** and his friend Nancy Ritzenthaler (SM '84). Dave and Nancy left the day after we saw them for a around-the-world trip of at least six months, starting with Hawaii and ending with Europe, with the Far East, Indonesia, and Australia in between. Dave and Nancy first met at an MIT Club meeting in their area. (Having first met Diane at a planning meeting for the class of '78 reunion, your class secretary can also vouch for the rewards of friends made through MIT alumni activities.)

Carol (Brown) Senne was elected to the post of Brevard County (Florida) Commissioner in a November 1988 election. In her job, she will be addressing the challenges of the county's dramatic growth and resulting transportation and development requirements. When not embroiled in planning and the consequent political action, Carol is, along with husband Sam Senne, taking care of the kids, Christine (age 8), Brian (age 7), and Samantha (age 6). They live in Grant, Fla. (All members of the family were really showing their talents on wheels at our 10th reunion roller skating party!)

Bob Maresca graduated from Stanford in 1980 and has worked in the field of high performance control systems, more specifically in the areas of motor control, magnetic bearings, and power processing. He is currently doing research at Bose Corp. in Framingham, Mass. Bob is living in Milford, Mass. . . . **Dan Zwillinger** writes from

Arlington, Mass. that his new book, *Handbook of Differential Equations* published by Academic Press, came out in January of this year.

And our former class secretary **Dave Browne** writes that he and wife Yuko have bought "a spanking brand new townhouse in Central Square, Cambridge, right near HiFi Pizza and the soon-to-be University Park Development (known to out-of-town classmates as the Simplex site). We're now experiencing the joys of making and hanging curtains and living without adequate furniture, counterbalanced by the joys of such technological wonders as our own thermostat, a working broiler, and dispos-all. (I want those engineers out there to know how much they're appreciated.) At work, I seem to have become University Hospital's efficiency specialist (although anyone who knows me well has difficulty putting my name and efficiency in the same sentence). . . The hospital operations area is always challenging, combining operations systems analysis, data analysis, some technical clinical issues, and good old-fashioned power politics. I'll get the hang of it in just a few more lifetimes. In the meantime, it's fun."

The lone voice from the Midwest is a pleasant note from Kathie Clay, Wellesley '78, wife of **Peter Clay.** Kathie writes that the Clay family recently moved to St. Louis where Peter joined Blue Cross/Blue Shield of Missouri as assitant to the president. Peter and Kathie have two children, Tiffany (age 4) and Thatcher (age 3), and are living in Chesterfield, a suburb of St. Louis. Before the move to the Midwest, the Clays were living in the Boston area since Peter's graduation from MIT and Harvard Business School in 1982. Kathie also writes that they traveled to Utah on a ski vacation where they met up with fellow Kappa Sigma classmates, **Eric Carr** and **Howie Seidler.**

All of you living in more predictable climates no doubt miss this fine time of year in Boston! As I write this column, Boston's traditional spring weather is upon us: yesterday brought us a small nor'easter with near-freezing temperatures, wet snow, and rain; today is sunny and calm, with a high of 45 degrees, but another nor'easter is predicted for tomorrow! I am participating fully in the Boston weather, rowing on the river, bright and early every morning. Scrimmage races against other national-rowing-team-hopefuls are coming up in the next two months. Send your news *TODAY!*—**Jim Bidigare,** Secretary, 659 Green Street, Cambridge, MA 02139

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By the time you read this, we will have had our 10th Reunion, and some of this news may already be old news. . . but here goes anyway.

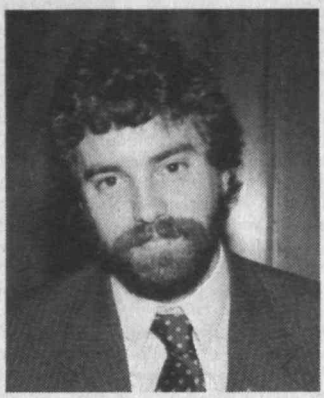
I just got off the phone with **Marla Eglowstein,** who called to announce the February 24th birth of Nathan Saul. Marla and husband Eliot Rich have been living in Manhattan for the last six years, but not for much longer. As of July, Marla will have completed her residency in obstetrics at Beekman Downtown Hospital and will be relocating to the Boston area, where she has a fellowship/assistant professorship lined up at St. Margaret's Hospital in Dorchester in the field of maternal/fetal medicine (a.k.a. high-risk obstetrics). Marla has also been managing, and playing cello in, the Doctor's Orchestra. Since Marla comes from an MIT family (her father was class of '53, her brother was class of '82, and her sister received her SB and SM this year), family expectations firmly place Nathan in the class of 2010! . . . Speaking of newborns, **Susan Ann Silverstein** wrote from Victor, N.Y., near Rochester, with news of the birth on February 18 of Elliott Benjamin Shiotani. Susan and husband Kenneth Seiji Shiotani are lawyers in Legal Services (she in housing law, he in welfare law), working in the same Rochester office. When Susan returns to work after her four-month maternity leave, she and Ken will both work part-time so that they can share the joys of parenting. Sounds like a great scheme to me. . . . **James Walker** taught acting last fall at the University of Maine, and performed in *Romeo and Juliet.* As of the spring, he was back in Boston appearing at the Lyric Stage. . . . **Kelly Clifford** has founded and is operating a consultation business in digital signal processing.

One of my first MIT friends, **Don Berry,** decided to come out of the woodwork. Don is an assistant professor in chemistry at the University of Pennsylvania, living in a "Back Bay"-style row house in Center City Philadelphia. Don was married last summer to Amanda Kunin. Don and Amanda sighted **Roger Silverstein** on, of all places, the television show *Jeopardy,* where he was a contestant last fall. Writes Don, "Apparently, Roger and his wife are both pediatricians and are living in the Detroit area. He won around $13,000 on the first night, but the next night he was trounced by a woman firefighter!" . . . **Steven Bauer** is a resident partner in the new Boston office of Allegretti & Witcoff, Ltd., a Chicago-based patent law firm. Steven will be specializing in the protection and enforcement of patents, copyrights, trademarks, and computer software. . . . **Steven Simonoff** started a software company in Salem, N.H., along with (among others) David Abrams, '75. Galactic Industries developed and publishes Spectra Calc, a scientific data processing package for analytical instruments such as FT-IR, NMR, gas chromatography, etc.

Mark de Lemos, who graduated MIT a year early, still wants to be a member of our class, and has accordingly provided an update on his activities for the last 11 years. Mark writes, "After MIT, I enrolled in the math PhD program at U.C. Berkeley. I stayed in the program for five years and then dropped out, finding math research to be less rewarding than I had hoped. I did wind up with a master's degree. I then lived in Edinburgh, Scotland, for a year, working as a computer programmer for the University of Edinburgh. What a fun year that was! I started in on my new hobby, Scottish Country Dancing. You should see me in my kilt! In the fall of '84, I returned to Berkeley and enrolled in a training program to become a high school math teacher. (Oh, noble aspiration!) At the end of the program, I wound up with a teaching certificate and a real dislike for public school education. I respect anyone who can stand to do it, but I couldn't. Next, I started on my current job, doing technical writing, quality assurance, customer support, and a little programming, for a very small applications software firm in Berkeley. One of my co-workers is Dave Barton, '77."

Pamela Berry is an attorney at Steptoe & Johnson in Washington, D.C., practicing tax law. Her work involves litigation and tax planning, primarily for corporations and other businesses. She recently gave birth to Daniel Berry Chamberlain. . . . **Jenny (Kern) Stern** finished her internal medicine residency at the University of Virginia in 1986, and is now working at a walk-in clinic in Durham, N.C. She was married in September 1987 to Herbert Stern, a pediatric cardiology fellow at Duke University.

Peter Fiekowsky lives in Santa Clara, Calif., with his wife Sharon and their infant son. Peter is engineering manager for a medical imaging startup, as well as consulting in image processing. He writes, "My big project is starting a conspiracy to have engineering known and practiced as a service, so we naturally see ourselves as serving people and their needs, and train ourselves to find out what's really needed." . . . **David Swanson** is "Married with children (two boys), living in Folsom, Calif. (just two miles from the prison). Working for Intel Corp. in the Peripherals/Microcom Product Group. No awards/publications/international assignments yet or in the foreseeable future. However, I'm looking forward to getting out of debt quite soon. Regards and best wishes to the NRSA gang." . . . **T.W. Kang** is the author of the book *Is Korea The Next Japan?,* recently published by the Free Press. He is a graduate of the Harvard Business School and is



Robert Hone, '79, a producer at KQED-TV in San Francisco, won the 1988 AAAS-Westinghouse Science Journalism Award for his efforts to report science on television. The $1,000 award, presented at the AAAS meeting in San Francisco in January of this year, recognizes the quality of Hone's "Science Notes," which aired throughout the contest year.

Hone holds both BS and MS degrees in chemical engineering from MIT. He worked as a chemical engineer at E.I. Dupont de Nemours from 1980 to 1983, then went to the University of California, Berkeley, to earn a master's degree in journalism before joining KQED in 1984.

He co-produces a series called "Health Notes," as well as "Express," a weekly current affairs program. In addition, he produces science segments for the MacNeil/Lehrer Newshour. His freelance articles have appeared in the San Francisco *Examiner* and the San Jose *Mercury News.* □

PHOTO: M. CHRISTINE TORRINGTON

the general manager of the systems business of Intel Japan.

John Dorsey, an aerospace engineer at NASA's Langley Research Center, was awarded the "Silver Snoopy" award by astronaut Frederick Hauck, commander of the Space Shuttle Discovery. John was honored "for analysis and design efforts in support of an alternate field joint for the Shuttle solid rocket motors." John holds an SM in aero/astro from the 'Tute in addition to his bachelor's and has been with NASA since 1982. . . . **Ron Parton** has joined Group Health, Inc.'s Riverside Medical Center in Minneapolis, Minn. Ron is in family practice and has an MPH from University of Washington, Seattle, in addition to his MD degree. The Partons live in Brooklyn Center.

Robert and I recently attended an MIT Alumni Center of New York event; namely, we attended MIT Professor Pete Gurney's new Off-Broadway play, *The Cocktail Hour,* then enjoyed a cocktail party which included the playwright and cast. We had a great time, and chatted with Vincent James, '78, Larry Kooper, SM '88, and Ted Hollenberg, '74, and his wife Rhoda Sperling. Speaking of the theatre, Robert and I will shortly be appearing in another Off-Off-Broadway play together. This time it's *Arsenic and Old Lace.* Playing my fiance is Charles Mobbs, '78. Wishing you all many happy opening nights.—**Sharon Lowenheim,** Secretary, 500 E. 63 St., Apt. 18B, New York, NY 10021

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Hi, this is **Guillermo Chang** substituting for **Jonathan Goldstein** who has just finished his midterms and is off to Tortolla in the British Virgin Islands to lounge in the sun for a well-deserved rest. As for me, I have also been very busy. I got married last year to Annmarie Barrett and just recently bought a house in Maynard, Mass.

Alan Taylor writes that he left his energy consulting job where he worked for five years. He is taking a year sabbatical before going back to get his MBA at UC Berkeley. He has traveled through Europe and Asia and is currently in San Francisco trying to start a rock band. We'll be looking for him in the pop charts. . . . **Steven D. Eppinger** received his PhD in mechanical engineering in August 1988 and is currently an assistant professor at the Sloan School of Management. . . . **Tom Dimauro** is currently at New York University law school trying to become a lawyer and is planning to get married later this year to Jane Willoughby. He says he misses Boston and plans to return soon. . . . **Kim Kao** is a manager for Avery Paper Products in California. . . . We hear from reliable sources that **Charlie Swanson** is finishing his PhD in economics at the University of Minnesota and soon will be heading to the University of Texas in Austin where he will be teaching. . . . February was a memorable month for some of us. **Melissa Miller** got married in Mexico City and Patty and **Michael Goldberger** had a baby girl. They named her Erica Fay. **David Weinstein** just got an MBA from Wharton and is now living on the upper west side of New York City and working for a consulting firm.

In closing I would like to remind you to keep those cards and letters coming in. The mailbag has been pretty light lately.—**Jonathan Goldstein,** Secretary, 2 Soldiers Field Park, #201, Boston, MA 02163

84

Sorry about the column last month—there was some confusion about it and we were not able to make the deadline. But that just means there is double the amount of news this month, aside from the fact that people have actually been writing in to let us know how they are doing.

The following news is from a mystery writer: **Soma Chaudhuri** is still working on her doctorate at the University of Washington but living in Chapel Hill, N.C., with her husband who is an assistant professor at University of North Carolina. . . . **Ron Reade** has started his PhD in January at UC Berkeley and is really into laser etching. . . . **Arnold Lee** has finished his graduate architecture studies at Harvard and is working on a real house. . . . **Mike Agronin** is married and still working at JPL. . . . **Frank Slaughter's** start-up company, Shiva Corp., pulled in around $5 million last year and is up to 25 employees. . . . **Natalie Lorenz** is consulting in the DC area and playing the bass. . . . **Tom** and **Betty (Beitz) Ransahoff** have moved to Connecticut where Tom is working on large scale chromatographic equipment. Betty's plans are still unknown. . . . Yet another letter from a classmate, **Tim Chambers.** He was kind enough to write in to give an update on himself and others in the class. . . . "Last month I decided to take a break from management at HP to work as a development engineer at the same HP division, logic systems. I'm now responsible for a new microprocessor instruction stimulator and debugger. . . . On August 20, **Viia Valge** married **John Archer.** She's working on her PhD at MIT and both are house tutors at MacGregor. **Peter Sterpe** and **Chip Whiting** were also there. Pete's now working at a desktop publishing software firm in Cambridge and married Tina Sabin in October. Chip is still with IBM in Burlington, Vt. **Carmen Fernandez** is finishing up her PhD at Penn."

John Einhorn wrote in to let us know that he is in the Mediterranean sea aboard the USS Theodore Roosevelt flying F-14's for the Jolly Rogers of VF-84. . . . **Howard Reubenstein** wrote in to tell us all about the "fifth annual Baker House in exile and associates New Year's Party" which was held in Tampa, Fla. "In attendence were: **Kim (Coldwell)** and **Frank Worley III** —Kim is in graduate school at Baylor College of Medicine in molecular genetics. Frank works for Rohm & Haas in process control; . . . Lori Brill, '85, and Howard Reubenstein (who is) taking up juggling salmon while pursuing higher education. Howard and Lori are planning to get married; . . . Kelly (Grant), '86, and **Chris Craven;** Chris is a development engineer at American Superconductor Corp. We'll (Chris and Howard) be skiing many, many weekends this year at Cannon Mt. in New Hampshire—come ski with us! . . . **Dennis Sacha**/Denise Neirinckx, '87;—Dennis is now in the real U.S. Navy flying A-6's and getting married to Denise when he returns. . . . **Dave Walter** is still working for Boeing. Working lots, traveling some, and still attending New Year's parties; future still totally unknown, but for now enjoying the Seattle life. . . . **Roy Glikin** is cheerfully employed. Not thinking about grad school. Making world safe for high-rises and suburban sprawl. . . . **Jew Yoon** is still working for Consilium as a software development engineer. Enjoying California, having lots of fun, but may decide to go back to school. . . . **Brett Hildebrand** says no comment (except for those scrawled out), life is quiet in the city. . . . From **Paul Bradford:** 'After four plus years in sunny California, I just moved back to Massachusetts (where all my family lives). I'm working at a software consulting company —so far the work is interesting.' " Sounds like a great party—make sure you write about it next year!!

A few final notes: **Bill LaPoint** graduated last June from Harvard B School, spent a summer in Europe with his wife Kathy, and then started working for Bain and Co. in Boston. . . . **Karen Welch** also graduated from HBS and is in Warren, Ohio, working as a general foreman on the manufacturing floor for GM. She also hopes we all have a great time at the 5th reunion (this year!!).

That is it from sunny California (where one can play volleyball and tennis all year around)—keep those letters coming, and thanks to all of those who wrote in this time around!—**Mona Wan,** Secretary, 12231 Viewoak Dr., Saratoga, CA 95070

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Jose Luis Cordeiro writes that he will be attending the 7th International Composite Materials Conference in Beijing, China. Jocelyn Patterson, '84, is helping to organize that conference. Jocelyn is now a captain in the U.S. Air Force and is stationed at Wright-Patterson AFB in Ohio. . . . **Rene Cornejo** is still working on his PhD degree in "something related to communication systems at Stanford." . . . **Richard Hahn** is attending New York Medical College in Valhalla, N.Y. "Match day" for residency positions was a few months ago. He will be pursuing psychiatry at NY Hospital, Cornell Medical Center. His roommate, **Ray Baer** will be doing internal medicine at University of Cincinnati. . . . **Robert Scharfman** will be doing ophthalmology at New York Medical College.

Charles P. Theuer finished han MD at University of California, San Francisco this spring. He is doing his general surgery residency at Harbor-UCLA Medical Center. He was married to Mari Doty on May 27th in Oakland. Charles says "hi" to his old basketball teammates.—**Stephanie Winner,** Secretary, (internet:winner@apple.COM), 1026 Live Oak Dr., Santa Clara, CA 95051, (408) 985-6827

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Greetings on April Fools Day! I hope everyone enjoyed Easter, Spring Break, or just the beginning of Spring. Lots of news this month so stay tuned. Don't change this channel.

Carl Tung wrote in all the way from England. He spent time there on business, training some French, German, and English customers for his company, Teradyne, Ltd. Carl was recently accepted at RPI where he plans to study for a master's in electrical engineering. He says it will be a major change to go from his jetsetting, globetrotting ways in Boston to school in Troy, N.Y. Carl got engaged in December 1988 in Taiwan during his business trip to Singapore. He will return in June 1989 to get formally engaged by Chinese standards to his childhood sweetheart. Congratulations, Carl!

Carl gathered some other info while working as an associate for the Alumni Fund. **Brian Mulcahey** has applied to business school and has heard, successfully I hope, from several top ten schools. **Al Rizzi** is working on a Ph.D. in electrical engineering at Yale. **Phil Parr** is pursuing an MBA at University of Michigan. **Sahba-Sadegh-Vaziri** is working at Drexel-Burnham-Lambert after graduating from Sloan School. **Songmin Kim** who has a wife Iris and a beautiful son, is finishing a master's in electrical engineering at MIT. **John Paul Mattia** is working at Lincoln Lab and **Michelle Lin** is breezing through her third year in medical school at University of Pennsylvania. **Jim Masucci** is working on a Ph.D. at University of Wisconsin. Carl asked me to mention that the Alumni Fund is a worthy cause and that being an associate agent gives all of us the chance to pick people to call. It's a lot of fun and Carl encourages everyone to help out. . . . **Andy Shooman** wrote in from Glen Cove, N.Y. He finished an MS in computer science at NYU in January. He has begun a Ph.D. (also in computer science) at Polytechnic University in Brooklyn where he also has a job as a TA in the computer lab. Andy helps the freshmen debug their programs and also helps the department head improve the computer facilities. During the summers, he works for Hazeltine Corp. on Long Island on projects ranging from artificial intelligence to signal processing. Andy also enjoys biking all over Long Island and his home in Glen Cove is only three blocks from the beach! Sorry, Andy, but I've got you beat. Mine's only a block from the beach. Anyone wanting to get in touch with Andy and has an Internet or Arpanet account can reach him at the following: ashooman%polycatt@graf.poly.edu.

Bob "Spike" Yancey wrote in from Sunnyvale

Calif. Bob says that after MIT, he went to Virginia Tech to be involved with the NASA-Virginia Tech Composites Program and to get a master's. He received that in February 1988 in engineering mechanics. While Bob was in Blacksburg, he got married (March 1988) and, after the honeymoon, moved to California. There he began working for Advanced Research and Applications Corp. (ARACOR). He is involved with developing industrial computed tomography (CAT scanners) for the nondestructive evaluation of composite materials. They are currently working on a high-resolution scanner capable of spatial resolutions better than 25 microns and able to image individual fibers in many composite materials.

That's it for the letters. On to Mary's Grape Vine. **Greg Harrison** and **Grace Tan** won the Sweetheart Division of the Playa Del Rey 5K Sweetheart Run this past Valentine's Day. I ran into **Joe Bush** and Rob Dare, '84, playing volleyball down at Hermosa Beach in mid-February. Joe works at Hughes where **Mark Caylor** now works. The two of them spent last Octoberfest in Munich and Mardi Gras in New Orleans. Sounds like fun. **Anne Fricker** spent the weekend here in Hermosa Beach in early February with Amy Austin, '87. The weekend before that, Anne was in Boston visiting **Karen Wohl** (at Harvard Business School) and **Ellen Epstein** (up from NYC). They also ran into **Anthony Scotti** and T.J. Cradick, '88. **Mark "Bismark" Emineth** was in Boston at the same time and just happened to find them at the Bow and Arrow pub in Harvard Square. What a coincidence. I heard that **Andy Sparks** got married in April (this year or last, I don't know) but congratulations anyway. Andy is still in Dayton, Ohio, putting in his time for the U.S. Air Force. I also found out that **Andy Solem** is at Wright-Patterson AFB along with Andy Sparks. . . . A long-awaited engagement was announced recently. **Marilyn Oberhardt** and Fred Barker are finally engaged and are looking at April 1990 for their wedding. Marilyn will be presenting a paper in May at the Tethered Satelite Conference in San Francisco.

Thanks for all the info. I really appreciate your inputs. As for me, wedding plans are firming up. We've picked Veterans' Day (November 11) as the big day. Talk to you next month!—**Mary E. Cox,** Secretary, 1800 Hermosa Ave., #A, Hermosa Beach, CA 90254

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I hope you've all enjoyed a wonderful spring and are taking advantage of the summer sun. Thanks for writing in, it makes all the difference. Well, here we go again.

Jose Rivero is working with Allis-Chalmers Corp. in Madrid, Spain, as a manufacturing systems engineer. He is in charge of all automation issues in the processing plants as well as the development of research and development operations. Now, Jose is working on the creation of a joint-venture operation with an electronics firm. . . . **Lisa Greber** is editor for *Science for the People* magazine. . . . Navy Ensign **Thomas A. Swengros** has recently reported for duty aboard the fleet ballistic missile submarine *USS Daniel Webster,* homeported in Groton, Conn.

Richard Singerman wrote from England. He's in his second year of a Marshall Scholarship at Trinity College, Cambridge University. He wrote: "It's great being at a place where you can go to the library and look at Newton's personal copy (complete with hand corrections) of the first edition of *The Principia.* Richard graduates this year with an advanced certificate in applied mathematics, and will most likely attend Cornell next year for further graduate work. (A Ph.D. in physics would be nice.) . . . **Neal Hoyer** wrote in to give an update on life in the Midwest. Neal is living in Saint Louis attending Washington University and working toward finishing his master's in mechanical engineering (this entails the analysis of cell mechanics using finite element analysis). He also has time for some travel and trumpet playing. Neal joined **Adam Kane, Al Blum, Michelle Kirshen, Stephen Levine** and **Eric Berman** skiing near Lake Tahoe and touring parts of California. It was decided that the skiing available out west would be illegal in Massachusetts or New England in general—too much snow for the east! Adam impressed the group with his mogel skiing, doing triple back flips off the bumps and making Stephen (former MIT Ski Team member) jealous. As for the trumpet playing, Neal had a special engagement performing with the combined Pep Band/Wind Ensemble for President Bush's visit to Washington University. Finally, Neal plans to remain in Saint Louis and take qualifiers for his Ph.D. in the fall. Good Luck, Neal!

Julie Marquet wrote from the Dominican Republic, where she has been working for the Peace Corps since August 1987. Julie works in the Child Survival/Health and Nutrition Program to improve community health and help decrease the infant mortality rate. Her daily routine includes weighing babies, counseling families on sanitation, control of parasites, treatment of diarrhea and nutrition. She also has a garden and teaches home gardening in addition to promoting breast feeding and boiling water (especially for young children). Julie wrote: "Along with the obvious benefits of learning Spanish, the Peace Corps has given me the unique opportunity to become completely immersed in a culture far different from our own. Dealing with the many old-wives tales that people believe so strongly in for lack of education is only one challenge. I would not change what I'm doing now for anything, yet I think by next December, when my term is up, I'll be ready to move on." Julie is planning a four to six month trek through South America before returning for a "real job" or to the academic world. If anyone is interested in the Peace Corp to get back to basics for a couple of years, travel, learn another language and culture, and do some grass-roots development work write: Julie Marquet, APDO 1412, Cuerpo De Paz, Santo Domingo, Dominican Republic. . . . **Kathy Millier** is also in the Peace Corps in Central African Republic, enjoying her experience teaching math and science in French to high school students. . . . **Ilga Skinkis** married Paul Berkalns last September; they are living in Park Ridge, Ill. Congratulations!

Last, but definately not least, I got a letter from **Steve Mackler.** After New Year's he spent some time in Boston—he managed to obtain an empty room in Baker (thanks to Ken D.) for the first week of IAP. During the week he saw and went out with several old friends from MIT, including Coops **(Steve Cooperman),** Lisa Schwartz, '89, **Ken Kharbanda,** Steph Squarcia, '90, Elaine and **Rob Hubal, Bob Frank, Jon Gruber,** Kamala Sundaram, '88, and Duncan, **Janet Zahradnik** and **Lowell Kim.** Then it was back to Austin, where Steve has a fellowship and a research assistantship at the University of Texas. He's working toward a master of science in aerospace engineering, specializing in guidance and control. Steve will be graduating in August and has begun to interview with aerospace and defense companies around the United States. In February, Steve and his roommate flew to New Orleans and met T.J. Cradick, '88, **Jeff Klohr, Ken Kharbanda,** Sue Behson, '88, and **Gene Cohen** for Mardi (Pardi?) Gras: Blenders and Beads, '89!! Steve's latest trip was to San Diego to visit **Ed Savard.** Ed's doing some sunny U.S. Navy training on Capistrano Island. While there, Steve also saw **Stacy Weinstein** (JPL) and **Ramin Tabibzadeh** (Rockwell). They're both very happy with L.A.

Thanks to everyone for all the info. Please keep it coming!—**Stephanie Levin,** Secretary, 41 Prentiss St., Cambridge, MA 02140, (617) 547-6673

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At this writing I am in the midst of packing for spring break. I just finished a string of exams and have nothing to do except bask in the UV rays on Puerto Rican beaches for the next eight days.

I would like to apologize for misspelling **Michele Sarin's** name in one of the previous issues. She writes that she is studying in a master's program for statistics at the Wharton School at University of Pennsylvania. In September she got engaged to Daniel E. Levy, a chemistry Ph.D. student at MIT. Congratulations to both of you!

Congratulations are also in order for **Daniel Anthony Pedrotti, Jr.** and his wife, Joyce. On March 23, 1989, they received a new addition, Daniel Anthony Pedrotti III, weighing in at 8 lbs. 1.5 oz. Dan Jr. works for Perini Land and Development. He received a master's in real estate development at MIT . . . **Al Devoe** is presently in San Diego working for an engineering firm, designing a capacitor factory for a Chinese group, which is to be installed in mainland China this spring. The exciting news, however, is that he "finished 39 out of 40 in the Coronado Pro-Am Longboard Classic, and decided he just really wants to surf." He moved to Hawaii at the end of March with his girlfriend Babette and is waiting tables at the Honolulu Chart House.

Clifford Yang is working at Otis Elevator in Farmington, Conn. He is an associate electrical engineer (sounds impressive!), doing electromagnetic interference testing for elevator controllers. He writes that he did a lot of skiing this past winter. (I wish I had!) . . . **John Seo** writes that he is but a poor grad student in biophysics. . . . **David J. Sperry** is keeping busy working for Amptek in Bedford on the Tethered Satellite System, along with Alan Huber, '69, and their Air Force liaison, Marilyn Oberhardt, '86.

Marine Second Lieutenants **Roger C. Hayward** and **Stephen E. Herrara** joined the Marine Corps in May 1988 and graduated from the basic school (Virginia) in February. . . . Navy Ensign **Timothy C. Benner** joined the Navy in February 1988 and has been commissioned in his present rank since he graduated from officer candidate school in Newport, R.I. . . . **Erik Heel** writes with lots of news. He spent the summer working in the research center of a steel plant in Finland. Highlights of his trip were visiting with his Finnish family, swimming in the Arctic Ocean (and you didn't come down with pneumonia?), and visiting the USSR. Sounds like it was an exciting summer! He was working with **Peter Schmidt** at Bolt Beranek and Newman Advanced Computers, Inc. (BBN ACI) in Cambridge, until he moved to Texas to start pilot training with the Air Force.

Peter Schmidt married Hollie Mahoney, '87, on October 8, 1988, in Arlington, Tex. After spending their honeymoon in Wisconsin, Peter and Hollie settled in Arlington, Mass. Hollie is working as a consultant for Temple Barker and Sloane in Lexington. . . . **David Kaffine** married Joan Coyne, '87, on October 30, 1988, in Bedford, Mass. After spending their honeymoon in Maine, Dave and Joan settled in Colorado Springs, Colo. Dave is working for NCR in the Microelectronics Division and Joan is working for Hughes Aircraft. Congratulations to both couples!

Ed Pickens just started in Eglin AFB and is soaking up the sun in Fort Walton Beach, Fla. Lt. Pickens is working as a project manager for AS-RAAM (Advanced Short Range Air-to-Air Missile). He will have to suffer through trips to England, Germany, and possibly Norway.

Dave Lin is attending medical school at Stoneybrook. . . . **Barbara Sannwald** is working for Oracle and will soon be transferred from Boston to Denver. In addition to work, Barbara is taking jazz composition class at the University of Denver. . . . **Mike J. Parker,** is in graduate school at MIT studying electrical engineering. Mike enjoyed being a tutor for 6.041 and is living in Tang. . . . **Ted Leung** is working on his master's in computer science at Brown. His main field of interest is parallel processing. Keep the news coming. Thanks to all who wrote! Have a terrific summer.—**Grace Ma,** Secretary, 435 East 30th St., New York, NY 10016

COURSE NEWS

I CIVIL ENGINEERING

Now that **Robert W. Antonisse,** SM '85, has returned from a three-year residence in The Hague, the Netherlands, where he worked as a transportation analyst for Hague Consulting Group (formerly Cambridge Systematics Europe), he is working as an operations analyst for the Massachusetts Bay Transportation Authority in Boston. . . . **Anne E. Carey,** SM '86, is a consultant in the fate and transport of chemicals from hazardous waste sites at Gradient Corp. in Cambridge with several other former Parsons Lab students. . . . **Alberto (Al) Calvo,** SM '72, has been promoted to division staff analyst at The Analytic Sciences Corp., where he is working on logistics engineering problems. . . . McGraw-Hill has published a new book for architects and engineers by **M. David Egan,** SM '66: *Architectural Acoustics* (1988). It is a successor to his 1972 book, *Concepts in Architectural Acoustics,* also published by McGraw-Hill. . . . **Ronald E. Nece,** ScD '68, spent academic year 1987-88 as a visiting professor at the University of Bradford in England while on leave from the University of Washington, Seattle. . . . **Valerie A. Lee ,** SM '76, is a trial attorney for the Environmental Enforcement Section of the U.S. Department of Justice in Washington, D.C.

II MECHANICAL ENGINEERING

Newly elected Fellows of ASME include **James V. Beck,** SM '57, and MIT Associate Professor **Carl R. Peterson,** ScD '63. . . . In the fall of 1988, **John E. Mayer, Jr.,** ScD '60, joined the Texas A&M University as the Allen-Bradley Professor of Automated Manufacturing in the engineering technology department and as a professor of mechanical engineering as well. . . . **Suzanne L. Butler,** SM '82, was recently promoted to assistant superintendent of manufacturing engineering at Harrison Radiator, a division of General Motors Corp. in Dayton, Ohio. . . . After retiring from Exxon Corp., **Richard P. Bernicker,** SM '59, put in a brief stint as head of the mechanical technology department at the University of Houston, and is now a vice-president of Rimkus Consulting Group, which specializes in forensic engineering.

Adrian Bejan, PhD '75, professor of mechanical engineering and materials science at Duke University, is the recipient of the Gustus L. Larson Memorial Award of the American Society of Mechanical Engineers. The award is given to an engineer who has demonstrated outstanding achievement in mechanical engineering within 10 to 20 years following graduation. Bejan has written three books, *Entropy Generation through Heat and Fluid Flow* (1982), *Convection Heat Transfer* (1984), and *Advanced Engineering Thermodynamics* (1988). All are published by John Wiley & Sons. . . . Two Course II alumni have been elected members of the National Academy of Engineering: **Philip A. Thompson,** ScD '61, professor in the Department of Mechanical Engineering, Aeronautical Engineering, and Mechanics at Rensselaer Polytechnic Institute, for his contributions to the understanding of the dynamic behavior of non-ideal fluids and for the discovery of liquefaction shock waves; and MIT's Quentin Berg Professor of Mechanical Engineering **Ali S. Argon,** ScD '56, for major contributions to the understanding of deformation and fracture of engineering materials through the application of mechanics to microstructure.

Graduate student **William S. Tuleen** was killed in a car accident on March 28 in Mexico, where he had gone for spring break. Tuleen, a graduate of Texas A&M University, had originally enrolled as a candidate for a dual degree in Ocean Engineering and the Technology and Policy Program, but switched to Course II this spring. He was a recipient of an NSF creativity award, which enabled him to study the drag forces on swimming animals. Only a small number of students receive NSF grants for which they themselves are responsible. Tuleen had completed his master's thesis, "The Strategic Dimension of Design," at the time of his death, but was not finished with his coursework.

The Alumni Association has received word of the death of **Constantin J.Monego,** SM '67, of Medford, New Jersey, on February 13. No further information was provided.

III MATERIALS SCIENCE AND ENGINEERING

Ralph G. Gilliland, PhD '68, has returned to Alcoa Technical Center as director of engineered products and processes after spending 1988 as director of programs and contracts at Alcoa's West Coast affiliate—Alcoa TRE—in the aerospace and defense industry. . . . Also now at the Alcoa Technical Center is **A. Robert Wasson,** PhD '78, who has been named division manager of strategy and venture analysis, where he is responsible for R&D portfolio analysis, business/market assessment, competitive analysis, and development of business strategy and R&D strategy for the Center's current R&D activities. Wasson was previously a principal with the management consulting firm of A.T. Kearney Technology. As a past president and director of the MIT Club of Northern California, he intends to help with the revitalization of the MIT Club of Western Pennsylvania now that he has moved back east. . . . **Steven J. Berman,** SM '73, sends word that he is "president of Paladin Consulting, Inc., a human resources performance improvement consulting firm working with clients like Consolidated Edison, Jamesway Corporation, etc. on quality, service, and performance improvement and employee involvement."

W.R. Prindle

Deborah D.L. Chung, PhD '77, currently a professor of mechanical and aerospace engineering at SUNY/Buffalo, is the inventor (with a patent pending) of a carbon-fiber-reinforced concrete that is inexpensive and twice the tensile and flexural strength of conventional concrete. She reports that further development of this will be sponsored by the Strategic Highway Research Program of NRC. She has also developed carbon-fiber-reinforced gypsum, a microporous calcium silicate thermal insulator, a flexible carbon-fiber composite, a superconducting paste, and a composite sorbent for methane-hydrogen separation.

Recently elected as a member of the National Academy of Engineering is **Frank F. Aplan,** ScD '57, a professor of metallurgy and mineral processing in the department of mineral engineering at Pennsylvania State University, University Park. He was cited for major contributions to the understanding of deformation and fracture of engineering materials through the application of mechanics to microstructure. . . . The 1989 recipient of the American Ceramic Society's Albert V. Bleininger Award is **William R. Prindle,** ScD '55, associate director of research, development, and engineering at Corning Glass Works. Prindle, a fellow and past president of the ACS, is a recognized authority on materials research.

Congressman **Donald L. Ritter,** ScD '66 (R-Penn.), is the recipient of ASME's 1988 Ralph Coats Roe Medal for his "effectiveness in explaining both the achievements and the constraints of the engineering profession to his colleagues in Congress and to the general public." In his lecture, "America in the Economic Olympics," presented to ASME's Winter Meeting late last fall, Ritter stressed the need for a faster rate of technology transfer. "To promote the success of U.S. world-class manufacturing," reported the *ASME News,* "Ritter recommended an agenda of six national imperatives 'where elected officials might be helped, encouraged, and educated' by the engineering community. These include: promoting quality as a way of work and life; putting technological hazards in more rational perspective prior to regulation; reducing the burden of litigation that dampens technological advance; reforming the education system to 'reprofessionalize' teaching and advance scientific and cultural literacy; and modifying the tax code to encourage greater long-term behavior in U.S. industry. Last, he mentioned the need for 'a federal R&D economy that is much more responsive to the global challenge of other world-class manufacturers than to classic pork-barrel pressures.' In other words, we need 'to better define federal R&D priorities.'"

IV ARCHITECTURE

Donald F. Ritter, SM '88, writes: "After returning to Canada, I formed my own business, which supplies an interactive video/animation system for use by experimental musicians and artists. The system has been successfully used in performances in Boston, New York, Toronto, and Karlsruhe, Germany." . . . **Todd L. Siler,** PhD '86, sends cryptic word that a major book of his will be published by Simon and Schuster in 1990. No clue as to title or subject—but stay tuned. . . . From Litchfield, Conn., **Barbara D. Putnam,** MAR '77, reports that she has been using Christopher Alexander's Pattern Language in her design work and finds it very valuable. She has a one-person design business so that she can work part-time and raise her daughter Emma, age 5. . . . **Richard C. Donkervoet,** MAR '53, has been advanced to the American Institute of Architects College of Fellows for "achievements in architectural practice and public service." He is president, COO, and chief design critic of Cochran, Stephenson & Donkervoet, Inc., a 60-person architectural and interior design firm in Baltimore, Md. Before joining the firm in 1957, Donkervoet worked in a variety of offices including Eero Saarinen/SHG, R. Buckminster Fuller, and Edward Durell Stone.

One of the first women to receive a master's degree in architecture at MIT, **Lois W. Langhorst,** MAR '40, died on January 6 at her home in San Francisco. She and her late husband, members of the Bay Area School of redwood regionalist architects, distinguished themselves by a noticeable Frank Lloyd Wright influence, to whom Mr. Langhorst had been apprenticed at Taliesen. According to her obituary in the *San Francisco Chronicle* (written by architectural critic Allan Temko) the Langhorsts' "unpretentious suburban houses, combining Wright's 'organic' philosophy with the social informality of Northern California, received national recognition and many awards." Langhorst was also an accomplished artist, and taught the history of architecture at the University of Kentucky from 1967 to 1973 and at the University of North Carolina from 1973 until she retired in 1981.

The Alumni Association has been notified of the deaths of **Frederick H. Reuter,** MCP '50, of Hendersonville, N.C., in April 1988; and **Jean-Michel Charuet,** MAR '63, on July 6, 1986 in France. No further details were provided.

V CHEMISTRY

Aloysius F. Hepp, PhD '85, has recently joined the permanent staff at NASA Lewis Research Center as a physicist. He is also a part-time lecturer in the chemistry department at Cleveland State University. . . . **Robert R. Moore,** PhD '86, writes that he is graduating in June from the University of Massachusetts Medical School with an MD degree and is "looking forward to a rewarding residency and career in family practice medicine. . . . **Virginia R. Cross,** PhD '76, is a staff chemist with Exxon Chemical in polymer development. . . . **Jean-Paul Lavalleye,** PhD '83, and his wife Lesley (Saunders, '82) are the parents of a young son and daughter. JP graduated from Georgetown Law Center in May 1988, passed the Virginia bar, and became a partner in the law firm of Oblon, Fisher, Spivak et al last December. Lesley is taking time off to spend with the little ones. . . . **Lan K. Wong,** PhD '77, associate professor of pharmaceutical science at the University of Pittsburgh, and a co-inventor have a patent pending on "peptidal steroids as antiarrhythmic agents." He has also initiated a China Pharmaceutical Exchange Program between U.S. and Chinese pharmaceutical institutes and industrial establishments.

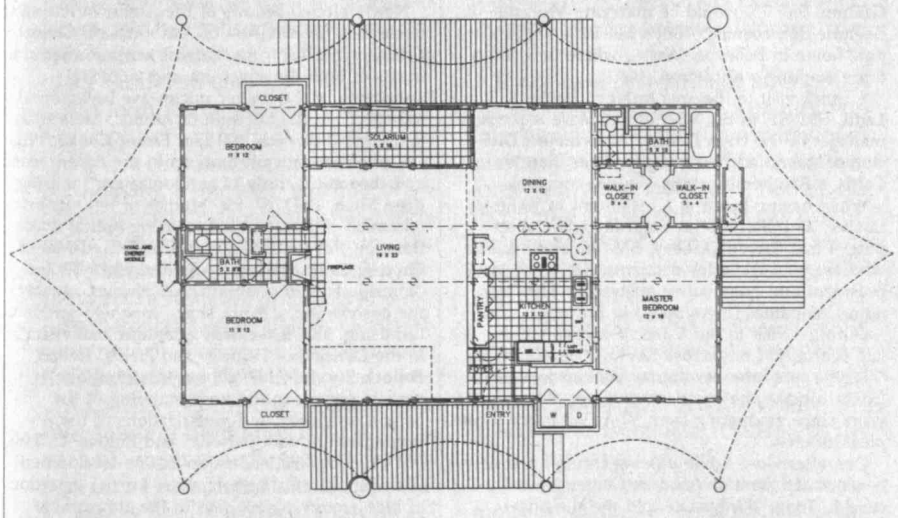
Stephen J. Lippard, PhD '65, has been named the Arthur Amos Noyes Professor at MIT. . . . **Nadine de Vries,** PhD '88, has been granted a NATO Fellowship and will be going to the Netherlands to study model complexes for nickel enzymes with Jan Reedijk. . . . Stanford University Professor of Chemistry **Barry M. Trost,** PhD '65, conducted the University of Pittsburgh's 34th annual Francis Clifford Phillips Lecture Series in early April. . . . Newly elected Fellows of the American Physical Society, Division of Atomic, Molecular, and Optical Physics: **John B. Delos,** PhD '70, "for his many contributions to the field of atomic and molecular collisions and for providing insight into the relationships between the classical and quantal behavior of atomic systems"; and **Richard Alan Gottscho,** PhD '79, "for new insights into the mechanisms of radiofrequency plasmas, and for new spectroscopic techniques for their characterization."

Laurent O. Dubois, SM '41, of Pocasset, Mass., died February 5 of a heart attack. For 33 years he was a chemical engineer in the explosives department of DuPont Co. until his retirement in 1973. His mother, the late Theresa H. Dubois, had been a prime mover in the Women's Suffrage Movement, and led Boston's Victory Parade in 1920 when the 19th amendment to the Constitution was ratified.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Robert Price, ScD '53, is now a consulting scientist at the research division of the Raytheon Co. in Lexington, Mass. . . . From California, **Arlyn W. Boekelheide,** SM '52, reports that he has recently retired from Hughes Aircraft Co., and plans to continue his consulting in the L.A. area. . . . **Willis H. Ware,** SM '42, chaired a National Research Council committee to examine computer security in the Department of Energy. . . . **Benjamin J. Leon,** ScD '59, has joined the NRC Board on Telecommunications and Computer Applications . . . **Howard L. Yudkin,** PhD '65, writes that he is "serving as president/CEO of the Software Productivity Consortium, an organization formed and owned by the leading members of the aerospace industry to develop tools and techniques needed to radically improve productivity and quality for mission critical software systems." . . . **Leonard Kleinrock,** PhD '63, has received his black belt in Shotokan karate. . . . **Douglas R. Cobb,** SM '65, joined Digital Equipment Corp. last May as resource center manager for telecommunications and utilities. . . . **Paul J. Shaver,** ScD '65, is now director of technology for EG&G Vactec Optoelectronics in St. Louis, Mo.

Jack Delmonte, SM '34, reports that in the past 10 years he has written and published three books: *Technology of Carbon/Graphite Fiber Composites* (Van Nostrand Reinhold), *Origins of Materials and Processes* (Technomic Publishing Co.), and *Metal/Polymer Composites* (Van Nostrand Reinhold—in press). . . . **Drew D. Peck,** SM '85, is a vice-president/securities analyst (semiconductor industry) for Donaldson, Lufkin, & Jenrette in New York City. He is married and has a young daughter. . . . **William F. Hederman, Jr.,** SM '71, was recently appointed chairman of the Pipeline Committee for the National Research Council's Transportation Research Board. . . . Purdue University Professor **LeRoy F. Silva,** SM '54, has been named a Sagamore of the Wabash by the now former Indiana Governor Robert Orr. The honor is the highest tribute that the governor of Indiana can confer, and is usually given to an individual who has rendered a distinguished service to the



FLOOR PLAN
SCALE: 1/4" = 1'-0"
SQ. FT: 1450

W. Randall Bray, MAR '64, has designed a cloth house kit that could cost as little as $25,000 ($45,000 completed). The acoustically and thermally insulated exterior and interior walls are 1'' thick quilted fabric; the ceiling is a translucent double envelope of fabric to allow in light. The house is expandable in stages (beginning with the master bedroom and bath) to approximately 1,450 square feet, and can be assembled in 45 days or less. Bray envisions his design as a potential economical solution for the first-home buyer since it is conducive to mass production at low cost.

L.F. Silva

E.L. Caples

state or the governor. Silva, director of Purdue's Business and Industrial Development Center, received the honor for his work with the Targeted Industries Program, part of the Indiana Department of Commerce. The program seeks to identify specific industries and encourage them to locate in the state.

Rockwell International Corp. has named **Ed Caples,** SM '71, as Engineer of the Year, the company's highest honor for technical achievement. Since 1976, he has been with Rockwell's Collins Defense Communications unit in Richardson, Tex., and is the lead engineer in the development of the Link Eleven Improvement System for the U.S. Navy, the primary network for distributing time-sensitive, tactical data throughout a battle group. Caples was cited for "his innovative network architecture and his willingness to share his knowledge with less senior engineers within the division [which] make him an outstanding example of the high engineering standard we strive for at Rockwell." . . . **Ron Haggarty,** SM '61, formerly chief engineer for MITRE Corp.'s C3I Group for Air Force Systems, has been promoted to director of research and technology. He joined MITRE in 1961 from the Lincoln Laboratory, and has had more than 30 years of experience in the field of signal processing applied to sensors and communications, with emphasis on spread-spectrum signaling.

Bhaskar Guha Roy, SM '85, a native of Bengal, India and a PhD candidate in Course VI, died on March 23 of liver cancer at age 29. His research on persistent objects for dataflow computing systems was undertaken within the Computation Structures Group of the Laboratory for Computer Science. . . . **Gerald G. Probst,** SM '56, former CEO of the Sperry Corp., died on January 16 in Salt Lake City. He was credited with restructuring the conglomerate into a $5 billion technology-oriented company that became Unisys Corp.

Of general departmental interest, it has been announced that Professor **Joel Moses,** PhD '67 (XVIII), has asked to step down as EECS department head at the end of August 1989. An ad hoc search committee, chaired by Professor **Paul L. Penfield,** ScD '60, has been established to make recommendations for a replacement to Dean of Engineering **Gerald L. Wilson,** ScD '65 (II). Professor Moses' departmental administrative team of associate department heads, Professors **Richard B. Adler,** ScD '49, and **Fernando J. Corbato,** PhD '56 (VIII), will also step down in concert with him.

VI-A Internship Program

The good news to report is that VI-A is definitely alive and well! One hundred fifty-four applications were received to fill the anticipated eighty openings of the 72nd class of the Internship Program. Although the same number of applicants applied last year, this year's are from a slightly smaller Course VI sophomore class: 63.1 percent of the class applied this year versus 57.9 percent in 1988—an increase of 5.2 percent. The highest ever percentage of applicants was back in 1983 when 63.7 percent of EECS sophomores applied!

Approximately 105 company representatives, faculty, and staff attended the VI-A Annual Dinner on March 6, which preceded the evening Open House held in the Student Center's Sala de Puerto Rico. Those VI-A'rs noted at the dinner included: **Richard B. Adler,** ScD '49 (MIT), **Dean R. Collins,** SM '59 (Texas Instruments), **Chester M. Day, Jr.,** SM '58 (Bellcore), **Charles B. Dieterich,** SM '78 (David Sarnoff Research Center), **Neil M. Haller,** SM '59 (Bellcore), **Ruby Li,** SM '88 (DEC), **Frederic R. Morgenthaler,** PhD '60 (MIT), **Joseph R. Otto III,** SM '89 (Hewlett-Packard Medical), **Steven L. Rohall,** SM '88 (Bellcore), **Alan Snyder,** PhD '79 (H-P Labs), **Nancy M. (Saraf) Stevens,** SM '82 (AT&T Bell Labs), **Bruce D. Wedlock,** ScD '62 (MIT), and **Craig L. Zarmer,** SM '84 (H-P Labs). My apologies to anyone overlooked—it was a big crowd!

Several of the companies, while on campus for VI-A recruiting, took their current students to dinner. Your correspondent was kindly included in TI's gathering held at the Cambridge Hyatt. Additionally, it was good to see so many company representatives with whom I've become acquainted over the years who returned to recruit.

Recently retired president of GenRad and now chairman of the board, **William R. Thurston,** SM '48, has been tapped by former U.S. Senator Paul Tsongas to serve on a new panel to develop guidelines for using trust funds to aid higher education in the Commonwealth of Massachusetts. Tsongas was recently appointed chairman of the Board of Regents by Governor Dukakis.

Mentioning Governor Dukakis, in March he toured several local companies in a statewide promotion of "Export 90's." One visit was to Brooktrout Technology, Inc. of Wellesley Hills, founded by **David W. Duehren,** SM '81, and **Patrick T. Hynes,** '81.

Over the years many officers of MIT's Tau Beta Pi chapter (Mass. Beta) have been VI-A students. This year's president is **Henry H. Houh** and president-elect for 1989-90 is **Joseph R. Babiec, Jr.** who also has just been elected president of the Class of 1990. Henry was elected secretary of this year's senior class. Other VI-A'rs serving Tau Beta Pi for 1988-89 are **Alfred (Sam) Hou** (corresponding secretary), **Natarajan Seshan** (recording secretary), and **Jeffrey C. Gealow** (cataloguer). **David S. Miller** will serve as cataloguer for 1989-90. I've been fortunate, over the years, in that a number of the Tau Bate officers have kept in touch (I complete my 33rd year on the Chapter's advisory board this June).

Recent contacts with VI-A alums include the following:

John R. Canfield, SM '87, wrote that he has taken a position with DEC's Professional Services, New Ventures Group, in Stow, Mass.

A telephone call on the day of his wedding (March 18) brought me the news that **Edward C. Giaimo,** SM '75, would be marrying Ms. Sue Boehme that evening. "Biff" will be living in a new home in Bellevue, Wash., where he'll continue working with Zetron, Inc.

A quick visit to the area brought **Steven K. Ladd,** SM '81, to the VI-A office. Steve is product manager of the High Density Interconnect Division of Advanced Packaging Systems, San Jose, Calif., a Raychem/Corning Venture company.

While having lunch at a restaurant in Wellesley Square, as I often do on Saturday while shopping, I met **Steven D. Levy,** SM '86, and his wife who are now Wellesley residents. Steve is a vice-president and quantitative analyst for The Putnam Companies (investment) in Boston.

During a visit to our Career Services Office, late February, I ran across **Kevin D. Stoddart,** EE '73, who was interviewing for Watkins-Johnson Co., a function he has performed for a number of years since graduating from VI-A. We had a most pleasant chat.

One afternoon, while passing through the newly renovated Stratton Student Center, I met **Lucene L. Tong,** '88. Lucene told me she's now studying medicine under the joint Harvard/MIT Health Sciences & Technology program.

Visitors signing the "VI-A Guest Book" since our last writing include: **Kenneth W. Conradt,** SM '87, with Merrill Lynch, NYC, in Boston for a symposium; **Robert P. Gilmore,** SM '77, with Qualcomm, Inc., San Diego, on campus recruiting for Qualcomm of which one of the founders is **Andrew J. Viterbi,** SM '57; **Tomohiro Hasegawa,** SM '85, with H-P Medical in Andover, Mass.; and **Lynn M. Roylance,** '72, recruiting for H-P Labs, Palo Alto.—John A. Tucker, Special Assistant to the Department Head for VI-A and Lecturer, MIT, Room 38-473, Cambridge, MA 02139.

VII BIOLOGY

Associate Department Head **Richard O. Hynes,** PhD '71, has been named to the Science Advisory Board of the Verax Corp., a U.S. bioprocessing company which provides commercial-scale technology for the production of high-quality biopharmaceuticals. Hynes, who is also a Howard Hughes Medical Institute investigator, brings to Verax his "state-of-the-art expertise in the field of cell-matrix interactions," said Verax Vice-President of Science John Vournakis.

Henry Sherman, PhD '46, of Longboat Key, Fla., died December 5, 1988, of complications from a stroke. Until he retired in 1981, he had been a senior research scientist at the Du Pont Co. for more than 26 years.

VIII PHYSICS

Joel M. Cherlow, PhD '72, received an MD from UCLA in 1979 and is currently practicing radiation oncology at Memorial Medical Center in Long Beach, Calif. "I have a particular interest in pediatric radiation oncology," he writes, "and am active in the Children's Cancer Study Group. Also, I have a clinical appointment at UCLA." Cherlow is married and has a young daughter. . .

Daryush-Ila, SM '82, is president of the Alabama Section of the Materials Research Society, director of the Center for Materials Irradiation at Alabama A&M University, and is also the Alabama liaison to the nationwide Materials Research Society membership committee. . . . **John A. Parmentola,** PhD '77, is one of three authors of *Making Space Defense Work: Must the Superpowers Cooperate?* published by Pergamon-Brassey's International Defense Publishers, Inc. in cooperation with the Roosevelt Center for American Policy Studies (1989). The book is described by the publishers as "the most comprehensive unclassified assessment available today of the strengths and weaknesses of Strategic Defense Initiative technology."

Newly elected Fellows of the American Physical Society: in the Division of Astrophysics, **George F. Smoot,** PhD '71, for "careful work on measurements of both the spectrum and large-scale anisotropy of the cosmic microwave background radiation"; in the Division of Atomic, Molecular, and Optical Physics, **William Ernest Cooke,** PhD '76, for "seminal contributions to the experimental and theoretical study of autoionization" and **Jagdeep Shah,** PhD '67, for "studies of hot carrier relaxation in semiconductors using optical spectroscopy"; in the Division of Condensed Matter Physics, **Emilio Eugenio Mendez,** PhD '79, for "contributions in quantum well physics, notably the observation of Stark shifts, magneto-resonant tunneling, and two-carrier quantum Hall effect"; in the Division of Particles and Fields, **Robert Pollock Ely, Jr.,** PhD '60, for "contributions in particle physics to the understanding of the baryon multiplets and investigations of the properties of quark partons" and **Eugene C. Loh,** PhD '61, for "his leadership in the development of the air scintillation technique for the detection of high energy cosmic rays in the atmosphere and its implementation in the Fly's Eye detector"; and in the Division of History of Physics, **Arthur I. Miller,** PhD '65, for "his research in the history of modern physics, especially the genesis of rela-

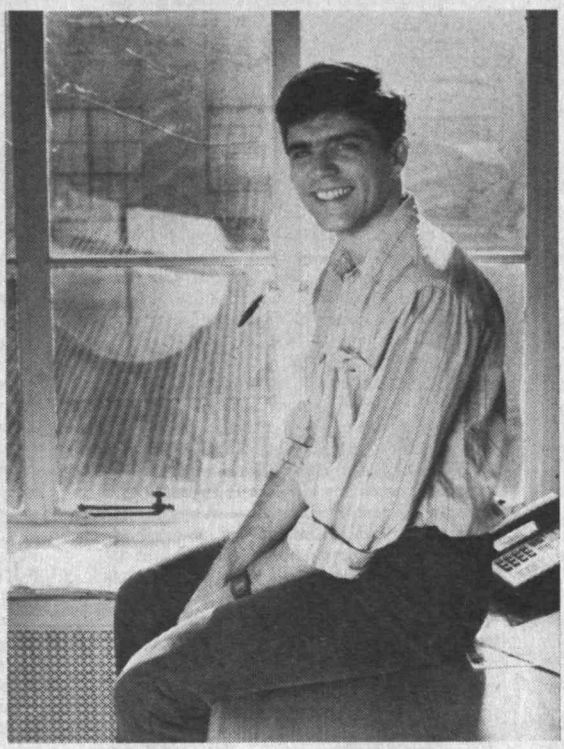
Surveying the Skies

By Vincent Kiernan

Astrophysicists have an embarrassing secret: For all their understanding of the wonders of the universe, they're not sure how far away much of the universe is. And this uncertainty over the distances of other galaxies ripples through the rest of astrophysics, making it impossible to pin down such things as the age of the universe and how much matter it contains.

Distance estimates are so complicated because a galaxy's brightness doesn't necessarily indicate how close it is. A dim object isn't necessarily far away; it might just be dim, period.

So astronomers have had to devise ingenious, indirect strategies for determining a galaxy's distance. Measuring the variable brightness of exploding stars and the galaxy's speed are some examples.



Estimates of nearby galaxies are used to figure the distances of more distant galaxies, so the whole system has become known as a "distance ladder." Any error in estimating distances to a relatively handy galaxy would be compounded in estimating distances to more remote objects, throwing the whole system way off kilter.

Complicating the problem is the fact that acrimonious debate among leaders in the field has split astrophysicists into two camps over the correct type of distance ladder to use.

But John Tonry, an associate professor of physics at MIT, believes that he has short-circuited the distance ladder by devising a one-step method of estimating distances to any galaxy. Tonry's method, published in the *Astronomical Journal* last September, depends on a statistical analysis of a picture of a galaxy generated by electronic cameras called charge-coupled devices (CCDs) attached to a telescope.

A CCD is a silicon chip comprised of thousands of individual light sensors, each of which is responsible for a tiny part of the completed picture. A nearby galaxy has an uneven, mottled appearance in CCD pictures—even if its stars are evenly distributed—because of random fluctuations in the amount of light reaching each light sensor in the CCD.

Tonry uses statistics to estimate how many stars the galaxy must have to produce a given amount of fluctuation. Given how bright the galaxy is and how bright the typical stars in the galaxy should be, he works backward to figure out the galaxy's distance from earth.

Tonry says that a major strength of his technique is that it doesn't rely on inferring distance from the behavior of bizarre, poorly understood celestial objects, such as variable stars. Rather, his technique just depends on the brightness of ordinary, garden-variety stars, which astrophysicists think they generally understand.

"Personally, I think that this is the benchmark around which people are going to compare their various techniques," he said. "That's where the value of this thing lies; it sidesteps the whole distance ladder."

He hopes eventually to use his technique to estimate the distance to the Virgo cluster, a large group of galaxies toward which our own is moving. This particular calculation is critical to resolving the distance debate: Researchers largely agree on the distances of many further galaxies relative to Virgo.

To calculate the distance to the Virgo cluster, Tonry will probably require observations that can only be made with the Hubble Space Telescope, a powerful orbiting telescope scheduled to be launched from the space shuttle later this year. However, Tonry still has to prove that the technique works. So far, he's had little chance to make necessary measurements with telescopes, but he planned to start doing that this spring at the Kitt Peak National Observatory in Arizona.

Meanwhile, experts in determining galactic distances are cautiously intrigued with Tonry's theory.

"It's a really cute idea . . . really novel," says John P. Huchra, '70, of the Harvard-Smithsonian Center for Astrophysics. "Whether it actually is going to work is another thing."

Proving the accuracy of Tonry's method won't be easy, Huchra warns. Analysis of CCD pictures works best with elliptical galaxies, but there are few elliptical galaxies close enough to have their distances reliably corroborated by alternative methods.

Paul Schechter, an MIT physics professor, notes that Tonry's technique depends on the assumption that all elliptical galaxies have similar stars.

"[Tonry's work] may prove as important or more important in determining the composition and ages of elliptical galaxies than in determining the distances to them," Schechter speculates. "Either way, it's going to be spectacular." □

VINCENT KIERNAN recently completed a year as a Knight Fellow in Science Journalism at MIT and plans to return to his post as science writer for the Alameda Newspapers, Inc., in California.

PHOTO: PAULA LERNER

tivity and quantum theory, and for popular lectures and articles on history of physics."

Newly inducted to the National Academy of Engineering: **James E. White,** PhD '49, the Charles Henry Green Professor of Exploration Geophysics at the Colorado School of Mines, for "advances in several major fields of geophysics and for the clear transmission of these advances to students and colleagues"; **John D.C. Little,** PhD '55, the George Maverick Bunker Professor of Management Science at the Sloan School, for "outstanding contributions to operational systems engineering including research, education, and applications in industry and leadership"; and **Elsa Garmire,** PhD '65, professor of electrical engineering and director of the Center for Laser Studies at the University of Southern California, for "contributions to nonlinear optics and optoelectronics and for leadership in education."

Professors of Physics **Michael S. Feld,** PhD '67, and **Felix M.H. Villars** were among the five MIT faculty members elected Fellows of the American Association for the Advancement of Science. McAfee Professor of Engineering **Norman C. Rasmussen,** PhD '56, was also elected a Fellow of the AAAS. . . . MIT Assistant Professors of Physics **Katherine Freese** and **John M. Graybeal** have been awarded Sloan Research Fellowships of $25,000 each over two years from the Alfred P. Sloan Foundation. The fellowships were established in 1955 to stimulate fundamental research by young scholars at a time in their careers when government and other support is difficult to obtain. Candidates are nominated by senior faculty members familiar with their talents.

Retired Cmdr. **Eugene Roy Christie,** SM '55, a scientist with the TRW Electronics and Defense Corp., died on January 17 following a stroke. He was 62 and lived in Rockville, Md. Christie retired from the military in 1967 after three years on a military liaison committee of the Defense Department and the Atomic Energy Commission. In the Navy, he served with several fighter squadrons during the Korean War, and in the late 1950s, after the Soviets launched Sputnik, he was assigned to the Lawrence Radiation Laboratory in Livermore, Calif. He then was based in Naples, Italy, in the Mediterranean defense force in the early 1960s.

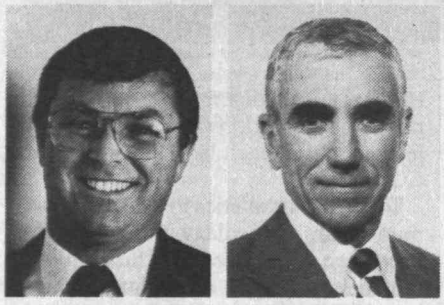
X CHEMICAL ENGINEERING

MIT Professor of Chemical and Biochemical Engineering **Robert S. Langer,** ScD '74, has been named recipient of the Founders Award for outstanding research by the Controlled Release Society, a group of 1600 scientists who specialize in research on administering drugs to humans. He was cited for pioneering studies of administering large molecules, such as the proteins now being produced by biotechnology. Also cited was his research that led to the creation of biodegradable polymers now being used clinically to treat brain cancer patients and his development of novel pulse delivery systems triggered by magnetism, ultrasound, or enzymes. . . . Associate Professor of Chemical Engineering **T. Alan Hatton** has been named director of the Chemical Engineering Practice School. He succeeds Professor **Jefferson W. Tester,** PhD '71, who has become director of the Energy Laboratory. Hatton received bachelor's and master's degrees from the University of Natal in Durban, and a PhD from the University of Wisconsin in Madison. His research interests include bioseparation processes, biocatalysis, transport phenomena, multiphase flows, and liquid extraction. He is the author of some 60 papers and has received a variety of awards, including the Everett Moore Baker Award for Excellence in Undergraduate Teaching at MIT, the Presidential Young Investigator Award, and the Merck Faculty Development Award. He currently holds the Class of 1922 Career Development Professorship.

Jaime A. Valencia, ScD '78, is one of four partners in Houston-based Novatec, Inc. Founded in 1986, Novatec began the development of a new environmental technology for the oil and gas industry to clean oily cuttings from drilling operations. After a successful prototype test in late 1988, Conoco bought all of Novatec's assets including the worldwide rights to the technology. Valencia will continue pursuing his interest in developing new technologies at the conclusion of his consulting agreement with Conoco. . . . **Andrew J. Heman,** CHE '72, is manager of process engineering at Fluor Daniel's Greenville, S.C., operations. . . . **Arunava Dutta,** ScD '85, is an advanced R&D engineer for GTE Products Corp. and is a member of Sigma Xi, AIChE, ACS, and the Electrochemical Society. His research interests are process simulation, process control & data acquisition, thin films, powder technology, and fluidized beds.

Earl E. Patterson, ScD '50, has retired from Reynolds Metals Co. . . . **Ernest O. Ohsol,** ScD '39, is working part-time as a consultant in environmental engineering, petrochemicals, and polymers. . . . **Pope A. Lawrence,** SM '37, writes: "I have been retired after 38 years as a commissioned officer of the U.S. Public Health Service. My work was scientific, and my retired rank is captain."

The American Physical Society has awarded its 1989 John H. Dillon Medal to **Frank S. Bates,** ScD '82, of AT&T Bell Laboratories for "his incisive and original experimental work on polymer phase transitions, especially through the design of model systems." . . . **Karen K. Gleason,** SM '82, has been named the Herman P. Meissner 1929 Assistant Professor of Chemical Engineering. Her research involves the relationship among atomic scale structure, preparation chemistry, and the optoelectronic properties of materials. She has used novel solid-state nuclear magnetic resonance techniques to explore the nature of defects in thin films. Gleason has taught at MIT since 1987.



T.A. Hatton *C.E. Dorman*

Among the 20 finalists named for the 1989 Inventor of the Year Award sponsored by the Intellectual Property Owners Foundation were **Abraham A. Domb** and **Robert S. Langer,** ScD '74, both of MIT, for their "small, biodegradable, plastic wafers implanted after surgery to dispense anti-cancer drugs slowly in the area of a tumor." The award went to four scientists from Genentech, Inc., for a product used to dissolve blood clots in heart attack victims. . . . The March 1989 *Chemtech* magazine contains an article on membrane separation technology by **Alan S. Michaels,** ScD '48, Distinguished University Professor of Chemical Engineering at North Carolina State University. The article is adapted from his presentation to the Fifth Annual Membrane Technology Planning Conference, where he received the Sponsors' Award for his "leadership, vision, and many technological contributions to the membrane industry."

Joseph M. Glassett, SM '48, and his wife Mildred were killed in a car accident on New Year's Day near Kingman, Ariz. The couple lived in Provo, Utah, where Joseph Glassett operated his own chemical engineering consulting business. He had been an associate professor at Brigham Young University from 1966 to 1980, where he taught and researched coal gasification, recovery of oil from tar sands, and recovery of minerals from brines. . . . **Dennis E. Johnson,** SM '56, a consulting chemical engineer with Arthur D. Little, Inc., for 28 years, died of a heart attack on February 3 at his home in Cambridge, Mass. He left ADL in 1984 to open Process Analysis International, a chemical engineering consulting firm in Cambridge. . . . The Alumni Association has been notified of the deaths of **George H. Shipley, Jr.,** SM '37, on January 20, 1988, and of **Charles E. Slyngstad,** SM '40, on November 7, 1984. Both had lived in Houston, Texas, but no further information was available.

XI URBAN STUDIES AND PLANNING

Guy Trottier, SM '56, is president of Groupe Conseil Polygec, Inc., and was made a Fellow of the Civil Engineering Society in 1989. . . . **Lucia K. Edmonds,** PhD '79, is a management and organization development consultant specializing in team building, conflict management, communications, and the management of diverse work groups. . . . **Camille M. Ascuaga,** MCP '85, has a new job as small-business liaison with the Department of Medical Security. "This is the new state agency," she writes, "that will make Massachusetts the first state to guarantee health insurance to *all* its residents." . . . In 1986, **Farokh Afshar,** PhD '86, became an associate professor at the University School of Rural Planning and Development at the University of Guelph, Ontario, and now coordinates the international development field. In 1987-88, Afshar conducted the Pakistan National Shelter Sector Review for the World Bank, and this year wrote the chapter "Rural Development with a Global Perspective" for a book on international planning education to be published by Plenum and edited by Bish Sanyal. . . . **Scott M. Soloway,** MCP '88, has been named an associate at the Boston law firm of Rackemann, Sawyer & Brewster. He also holds a JD from the Boston University School of Law.

George W. Malaney, who attended MIT on a special fellowship program from 1956-57, died August 12, 1988 in Nashville, Tenn., where he was professor of environmental engineering and biology at Vanderbilt University for 26 years. He also taught at Ohio State University for 10 years.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

Another honor has come to **Edward N. Lorenz,** ScD '48, professor emeritus of meteorology at MIT, this time from The Franklin Institute of Philadelphia, which is awarding him its Elliott Creson Medal. The Institute cited him for "his discovery, recognition, and interpretation of dynamical chaos in physical systems, and for his impact upon the scientific, mathematical, and technological communities." . . . **Kelly K. Falkner,** PhD '89, is one of 54 young U.S. scientists and engineers selected to receive a NSF-NATO Postdoctoral Fellowship in Science award. She will use the award for full-time postdoctoral study in geochemistry at Centre Nationale d'Etudes Spatiales in Toulouse, France. . . . **Stewart Nozette,** PhD '83, is co-editor, along with Robert Lawrence Kuhn, SM '60 (XV-A), of *Commercializing SDI Technologies* (Praeger, 1987).

Craig E. Dorman, PhD '72, a physical oceanographer with more than 20 years of administrative and field experience in the U.S. Navy, has been named the sixth director of the Woods Hole Oceanographic Institution, succeeding John H. Steele. Dorman retired from the navy as a rear admiral in January. He had been program director for antisubmarine warfare in the Space and Naval Warfare Systems Command. He was one of the first students in the MIT/Woods Hole Joint Graduate Education Program. His thesis focused on coastal processes and air-sea inter-

PHOTO: DONNA COVENEY

action. . . . **Francis E. Courtney, Jr.,** SM '52, reports that he "is completing 45 years in meteorology this year as an active professional."

XIII OCEAN ENGINEERING

MIT Professor of Naval Architecture **John N. Newman,** ScD '60, was recently elected to membership in the National Academy of Engineering for "outstanding contributions to theoretical and applied hydrodynamics of ships and ocean structures. . . . Navy Comdr. **Daniel G. Hickey,** SM '72, has been deployed to the Indian Ocean while serving aboard the destroyer tender *USS Puget Sound* out of Norfolk, Va. During the six-month deployment, Hickey will provide repair and maintenance services to ships deployed in the Mediterranean Sea, Indian Ocean, and Persian Gulf.

XIV ECONOMICS

George C. Galster, PhD '74, has been appointed to the advisory panel that will design, implement, and analyze results from the HUD-sponsored National Housing Discrimination Survey, which will be conducted in 25 cities during 1989. . . . **Chris C. Tilly,** PhD '89, has been promoted to assistant professor at the University of Lowell. . . . MIT Professor of Economics **Peter A. Diamond,** PhD '63, has been named as the first holder of the John and Jennie S. MacDonald Professorship, established by a gift from Edmond MacDonald, '21, in memory of his parents. Diamond, who was head of the Department in 1985-86 and associate head before that for a number of years, is an authority on taxation, social security, and uncertainty theory. He is beginning to work in macroeconomics. . . . **Bruce Rubinger,** '75, is the author of *Applied Artificial Intelligence in Japan,* published by the Hemisphere Publishing Corp. He is the director of studies at the Global Competitiveness Council in Boston, a high-tech research firm that analyzes worldwide technical trends.

William R. Miller, SM '37, a retired naval captain and public-health engineer, died on February 20 of cancer in Baltimore, Md. He retired from the Navy in 1960 and returned to his native Baltimore to work as a public-health engineer in the design and implementation of occupational health and safety standards with the Maryland Department of Health and Mental Hygiene.

XV MANAGEMENT

Amy Grossman Raine, SM '78, has left Theodore Barry & Associates and joined Merritt Real Estate Group as a commercial real-estate broker in Los Angeles. . . . **Miles M. Harbur,** SM '77, was promoted to vice-president and general manager of Stock Computer Forms, an $80 million unit of Reynolds & Reynolds Corp. . . . **Marcia A. Krolikowski,** SM '77, has joined Coldwell Banker in Lexington, Mass., and will be offering residential real-estate services throughout the Commonwealth. . . . **Janet L. Park,** SM '80, has established a new venture, Marketing Frontiers, Inc., a marketing consulting firm that specializes in "using new technology to reach new markets." Her offices are in Kendall Square, and MIT is her new landlord. . . . **Nancy E. von Hone,** SM '84, was transferred to Southern California last year to do some major account selling for the Butcher Co., for whom she's worked for the last three years. Now she has been reassigned to a high-priority marketing project based in Los Angeles, but "still finds time to squeeze in some biking and sailing." . . . **Stanley C. Abraham,** SM '68, sends word that he is no longer teaching at Pepperdine University, but is consulting full-time. He now has two sons, Mark and Jason. . . . **J. Buck-**

Left to right: G. Kennan, J. Goodall, E. Gombrich, P. Samuelson, S. Hawking.

Britannica Honors Communicators

MIT Professor of Economics Paul A. Samuelson is one of five recipients of the 1989 Britannica Awards for "excellence in the dissemination of knowledge for the benefit of mankind." Sharing the honor are theoretical physicist Stephen W. Hawking; ethologist and chimpanzee authority Jane Goodall; scholar, author, and diplomat George F. Kennan; and art historian Sir Ernst Gombrich.

Each award carries with it a gold medal, $25,000, and an invitation to deliver a Britannica Lecture at a university or similar setting. The encyclopaedia publisher acknowledged the numerous contributions to the "sum of knowledge" of its honorees, but placed its strongest emphasis on their ability and endeavors to communicate that knowledge to others.

Samuelson, the first American to receive the Nobel Prize in Economic Science, was cited for being "unexcelled as an interpreter of economic theory to college students for 40 years and to the highest levels of government for very nearly as long." In addition to service on President John F. Kennedy's Council of Economic Advisors and membership on the Federal Reserve Board, Samuelson's continuing efforts to communicate what he knows include a long-running column in *Newsweek,* numerous articles published elsewhere, and two major books—*Foundations of Economic Analysis* (1947) and the textbook, *Economics: An Introductory Analysis* (1948).

"Like Martin Luther King, I, as an economist, have a dream," said Samuelson at the press conference announcing the award recipients. "I have a dream of a realistic and efficient economics that is also a humane economics. Just because the heart is warm does not mean the head has to be soft.

"One vow I try hard to live up to: Never speak of efficiency in policy formulation without studying the tradeoffs that are implied for equity and justice."

Though admitting that economics has earned the title "the dismal science," it is something more, Samuelson said. "If the facts call for blood, sweat, and tears, I can be as unsparing a messenger as science requires. . . . However, it is my honest reading of economic history and world trends that—in the words of Dr. Samuel Johnson's friend—cheerfulness keeps breaking in."

Despite famines that overtake various parts of the world, he said, he is encouraged by reports "of enhanced life expectancies in most regions. . . . Three score and 10 years is becoming no longer the monopoly of the industrialized regions of the world." He also expressed optimism inspired by the "convergence toward the center observed in Moscow, Peking, Washington, and New Delhi."□

PHOTO: KPI

N.S. Novich

T.W. Malone

ner Brown, SM '82, writes: "Am currently residing in Tokyo, where I am active with Shearson Lehman Hutton's mergers and acquisitions and other investment banking activities."

A note from **Ken Brock,** '48, regarding a trip with family members to the Copper Beech Inn in Ivorytown, Conn.: "Saw a copy of *Tech Review* and wondered whose it was. Ergo, met Sally & **Eldon Senner,** SM '71—the proprietors—for the first time. A lovely inn, with beautiful antique-filled rooms. Dining room is superb, gourmet! Highly recommended. Wonder how many Sloan alumni are innkeepers?" . . . **Richard R. Wood** '48, has bought out his partner and moved his business, Renwood Properties, Inc., back to Boston. He now lives on Memorial Drive, and has two grandchildren. . . . .**Neil S. Novich,** SM '81, has been named a vice-president of Bain & Co., Inc. Before joining Bain as a consultant in 1981, he was a senior mechanical engineer with Gould, Inc., and a research associate in the MIT Gas Turbine Laboratories. He also has an SM in nuclear engineering from MIT.

Thomas W. Malone, Douglas Drane Career Development Associate Professor in information technology and management at Sloan, has been named the first holder of the Patrick McGovern Professorship in Management Information Systems. The chair was established in 1987 by Patrick McGovern, '60 (VII), with a pledge of $1.5 million. McGovern is founder and chairman of International Data Corp, a market research organization that provides facts and figures to the computer world. IDC publishes *Computerworld* (the largest computer magazine in the country), *MacWorld, PC World,* and nearly 100 other newspapers and magazines. Malone is a world leader in the fields of human-computer interaction and computer supported cooperative work, as well as a pioneer in the emerging interdisciplinary study of coordination. His research focuses on how artificial intelligence and other computer technologies can help people work together in groups and organizations. He is also concerned with how organizations can be designed to take advantage of the capabilities provided by information technology.

Sloan Fellows

F.E. Ellis, SM '70, retired as executive vice-president of Conoco, Inc. (group vice-president of E.I. DuPont De Nemours) on December 1, 1988, after nearly 34 years of service. . . . **Robert Lawrence Kuhn,** SM '60, along with Stewart Nozette, PhD '83 (XII), is co-editor of *Commercializing SDI Technologies* (Praeger, 1987).

Senior Executives Program

The Alumni Association has received word of the deaths of **Edward H. Seymour,** '66, on December 24, 1988, and of **Philip J. Lawrence,** '62, on January 20, 1989. No further information is available.

XVI AERONAUTICS AND AND ASTRONAUTICS

Frank C. Sakran, Jr., SM '67, was elected president of the International Omega Association, a professional society serving persons having an interest in the Omega radio navigation system which provides global positioning and navigation service through the cooperation of seven partner nations. . . . **Ronald L. Nave,** SM '70, is currently pursuing academic studies toward a degree in electrical and computer engineering at Drexel University "due to slow job market in aero engineering," he says. "Am having fun on my home PC computer." . . . Among the 20 finalists named for the 1989 Inventor of the Year Award sponsored by the Intellectual Property Owners Foundation was **J. Edward Anderson,** PhD '62, an inventor of patents obtained by the University of Minnesota for "the 'Taxi 2000,' a personal rapid-transit system utilizing small, light-weight guideways." The award went to four scientists from Genentech, Inc., for a product used to dissolve blood clots in heart attack victims

A team of four MIT aero/astro students has won the $1,000 first prize in the AIAA Allied Design Competition. **Mark S. Andersson, M. Roman Hachkowski, Charles W. Whetsel II,** and **E. Michael Fincke,** all seniors and members of the student branch of the AIAA at MIT, won with their design of an antenna-array satellite using rigid inflatable structures. Their advisor was Professor **James W. Mar,** ScD '49. . . . Last March, a "Frontiers in Computational Mechanics" symposium celebrated the 70th birthday of MIT Professor **Theodore H.H. Pian,** ScD '48, and honored his lifetime contributions to the finite element computational method, plasticity, structural integrity, and structural design.

The Alumni Association has been notified of the death of **Robert D. Collins,** SM '54, in April 1985. He had retired from IBM as a systems development engineer in 1976.

Correction: **Alfred M. (Morine) Pride,** SM '60, was erroneously included in *Technology Review's* list of Deceased Alumni in the May/June issue. It was actually his father, **Alfred M. (Melville) Pride,** who died on December 24, 1988. The elder Pride had attended MIT as a special graduate student in Course XVI for one semester in 1926. We apologize for the error—*ed.*

XVII POLITICAL SCIENCE

Anne H. Cahn, PhD '71, is now a senior MacArthur Scholar at the Center for International Security Studies at the University of Maryland. She is writing a book about the collapse of detente in the seventies. . . . Lt. Col. **Michael C. Ryan,** PhD '86, had a White House Fellowship in 1986-87, was promoted to his present rank this past February, and is currently assigned as the executive officer of the First "Tiger" Brigade, 2nd Armored Division, in Fort Hood, Tex. . . . **Richard E. Sclove,** PhD '86, writes: "I married Marcie Abramson (one-time chef at the F&T diner) in June 1988. We live happily in Amherst, Mass., where I direct the Loka Institute, a non-profit organization that promotes democratic involvement in technology, science, and architecture. When not crusading on the world's behalf, I can sometimes be found lending a hand at Amherst's new restaurant, Marcie's Place. Come eat!"

XX NUCLEAR ENGINEERING

Newly elected as a Fellow of the American Physical Society in the Division of Plasma Physics is **Weston M. Stacey,** PhD '66, for "outstanding contributions in the application of plasma physics to fusion-reactor concepts, and for international leadership in multi-disciplinary reactor design activities." . . . **Eric C. Guyer,** ScD '77, founded a new company called Yankee Scientific, located in Ashland, Mass. It does mechanical engineering development work. Guyer is also the editor-in-chief of the new *Handbook of Applied Thermal Design* (McGraw-Hill, 1989).

OBITUARIES

Deceased

The following deaths have been reported to the Alumni Association since the *Review's* last deadline:

Walter P. Muther, '13; April 4, 1989; Westhampton, Mass.
Philip O'Keefe, '16; February 1989.
Henry P. Pinkham, '16; November 28, 1988; Wollaston, Mass.
George W. Thomas, '18; January 28, 1989; Natick, Mass.
John W. Rogers, '19; February 27, 1989; Kirkwood, Mo.
Valborg A. Aschehoug, '20; March 11, 1988; Oslo, Norway.
Moses B. Pike, '20; March 13, 1989; Lubec, Maine.
Robert S. Cook, '21; February 21, 1989; Fort Lauderdale, Fla.
Roderick K. Eskew, '21; March 4, 1989; Sanibel, Fla.
Goodman Mottelson, '21; September 8, 1988; Chislehurst, Kent, England.
Edson I. Schock, '21; October 21, 1988; Kingston, R.I.
Henry C. Stillman, '21; December 21, 1988; Amherst, Mass.
John R. Daesen, '22; March 9, 1989; Park Ridge, Ill.
John M. Goodnow, '22; March 16, 1988; Damariscotta, Maine.
Walter C. Pew, '22; March 14, 1989; Gladwyne, Penn.
Thomas B. Stewart, Jr., '22; 1988; Belmont, Calif.
P.J. Alwin Zeller, '22; December 13, 1988; College Station, Tex.
Howard T. Clark, '23; December 27, 1988; Hallowell, Maine.
Charles K. Miller, '23; August 31, 1988; Lancaster, Penn.
Wilbert M. Gilman, '24; March 30, 1989; Wellesley Hills, Mass.
Mrs. Edward (Dorothy) J. Hanley, '24; December 29, 1988; Allison Park, Penn.
Arthur J. Kemp, '24; December 17, 1987; New Canaan, Conn.
Tien A. Koe, '24; March 23, 1988; Honolulu, Hawaii.
Edward A. Saibel, '24; April 9, 1989; Durham, N.C.
Robert E. Dodd, '25; January 5, 1989; Buffalo, N.Y.
Stephen Freeman, Jr., '25; June 2, 1988; West Lafayette, Ind.
Flavel D. Ray, '25; November 26, 1988.
Frank H. Riegel, '25; March 23, 1989; Leicester, Mass.
Richard W. Batt, '26; January 2, 1989; Wethersfield, Conn.
Royal Boston, Jr., '26; January 22, 1989; Southern Pines, N.C.
Ralph E. Colclesser, '26; September 28, 1988; Stuart, Fla.
Argo E. Landau, '26; January 1986; St. Louis, Mo.
Charles G. Moody, '26; March 24, 1988; Washington, D.C.
Thomas T. Neill, '26; July 29, 1988; Washington, D.C.
Dwight H. Woods, '26; March 1, 1989; Kerrville, Tex.
George E. Alfred, '27; December 25, 1988; Mount Kisco, N.Y.
Arthur J. Buckley, '27; December 7, 1988; Williamsport, Md.

PHOTO: BRADFORD F. HERZOG

Michael R. Campbell, '27; 1988; Sydney, Canada.
Thurston K. Decker, '27; March 2, 1989; Gulfport, Fla.
Robert J. Dorey, '27; March 4, 1989; Wayland, Mass.
J.B. Hamblen, '27; March 3, 1989; Franklin, Ind.
Richard P. Innerasky, Jr., '27; March 15, 1989; Dennis, Mass.
John D. Kuhns, '27; February 5, 1989; Springfield, Ohio.
William M. Lempka, '27; October 11, 1988; Smallwood, N.Y.
Edgar Marburg, '27; March 20, 1989; Rockville, Md.
Dudley S. Young, '27; December 12, 1988; Toronto, Canada.
Samuel W. Marshall, Jr., '28; December 14, 1988; Dallas, Tex.
Gordon F. Rogers, '28; January 23, 1989; Oakland, Calif.
Bruce E. Sherrill, '28; February 13, 1989; Milford, Ohio.
Mrs. Joseph C. Whitcomb, '28; February 14, 1987; Middleboro, Mass.
Charles E. Worthen, '28; February 25, 1989; Santa Rosa, Calif.
Joseph H. Durkee, '29; December 16, 1988; Jacksonville, Fla.
Edward A. Yates, '29; December 1, 1976; Ann Arbor, Mich.
Robert A. Canning, '30; January 6, 1989.
Mary Ann E. Crawford, '30; December 19, 1988; Chicago, Ill.
Howard S. Gardner, '30; May 4, 1988; Laguna Hills, Calif.
J(ohn) Allan Mathews, '30; February 11, 1989; La Jolla, Calif.
Bertil A. Ryberg, '30; November 27, 1988; Wareham, Mass.
William H. Spahr, '30; March 30, 1989; Smithtown, N.Y.
Donald E. Stearns, 30, February 19, 1989; Erieville, N.Y.
Howard Z. Bogert, '31; December 3, 1988; Santa Barbara, Calif.
Frederick A. Dartsch, '31; December 6, 1987; Washington, D.C.
Victor J. Duplin, Jr., '31; April 3, 1989; Lynchburg, Va.
Harold D. Gurney, '31; April 6, 1989; Quincy, Mass.
Joseph B. Shea, '31; February 14, 1988; Piscataway, N.J.
Leslie K. Snowdon, '31; March 22, 1989; Rye, N.H.
Ray Hawksley, '32; May 26, 1987; Greenbrae, Calif.
Morris M. Newman, '32; January 19, 1989; Marblehead, Mass.
Lewis M. Burrows, '33; February 10, 1989; Shreveport, La.
Asa H. Jewell, '33; February 9, 1989; Franklin, Tenn.
Robert G. MacKay, '33; May 4, 1988; Stillwater, Maine.
John D. Williams, '33; December 31, 1988; Medfield, Mass.
Harold S. Adams, '34; January 10, 1989; Indianapolis, Ind.
Bennett Fisher, '34; January 3, 1989; Greenwich, Conn.
Wolfgang F. Rahles, '34; January 1989; Worthington, Ohio.
Jerome M. Raphael, '34; April 3, 1989; Lafayette, Calif.
Dexter Stevens, '35; February 17, 1989; Wells, Maine.
Leonard S. Wiener, '35; November 16, 1988; Mission Veijo, Calif.
Fred H. Flint, '36; December 16, 1988; Amherst, N.Y.
Roswell C. Peavey, '36; February 17, 1989; Richardson, Tex.
A(lbert) James Ullman, '36; October 18, 1988; Cleveland Heights, Ohio.
Charles G. Hammann, '37; 1986; Woonsocket, R.I.
Gray Jensvold, '37; January 19, 1989; Morrisville, Vt.
Frank W. MacDonald, '37; February 21, 1989; New Orleans, La.
William R. Miller, '37; February 20, 1989; Baltimore, Md.
Matthew L. Rockwell, '37; December 7, 1988; Winnetka, Ill.
John G. Burke, '38; February 21, 1989; Tulsa, Okla.
Gerson Hermann, '38; 1985; Clark, N.J.
H. King Cummings, '39; March 25, 1989; Stratton, Maine.
George J. Laurent, '39; March 1, 1988; Wrightstown, Penn.
John F. Stiff, '39; March 25, 1989; Downers Grove, Ill.
Thomas P. Bowman, '40; April 12, 1989; Southbury, Conn.
Allan W. MacKay, '40; January 1988; Mt. Royal, Canada.
Charles E. Slyngstad, '40; November 7, 1984; Houston, Tex.
Earl H. Krohn, '41; December 1988; Chestnut Hill, Mass.
William D. Potter, '41; April 5, 1989; Quincy, Mass.
A(lexander) Forbes Robb, '41; February 28, 1989; Danvers, Mass.
George H. Hotte, '43; March 10, 1989; Palm City, Fla.
Warren L. Knauer, '43; March 6, 1989; Winnetka, Ill.
John M. Watts, '43; March 22, 1989; Mystic, Conn.
Roland Benjamin, Jr., '44; December 9, 1988; Spring Lake, N.J.
Harvey A. Cox, Jr., '44; March 16, 1989; Greensboro, N.C.
Scipio de Kanter, '44; January 22, 1989; Missouri City, Tex.
Chester L. Woodworth, '44; February 3, 1989; Coral Gables, Fla.
Robert P. Mack, '45; August 22, 1986; Los Angeles, Calif.
Donald W. Sabean, Jr., '46; March 26, 1989; Pembroke, Mass.
Deross Salisbury, Jr., '46; December 24, 1988.
Henry Sherman, '46; December 5, 1988; Longboat Key, Fla.
Maitland A. Baker, '47; December 10, 1988; Kingston, Tenn.
Robert L. Solnick, '47; February 1988; Corona Del Mar, Calif.
R(obert) Langdon Wales, '47; March 14, 1989; Lincoln, Mass.
Joseph M. Glassett, '48; January 1, 1989; Provo, Utah.
Richard J. Nickerson, '49; December 2, 1988; Lynn, Mass.
Frederick H. Reuter, '50; April 1988; Hendersonville, N.C.
Ernest F. Jensen, '51; March 1, 1988; Jacksonville, Fla.
James S. Gibson, '52; March 15, 1989; Kearny, N.J.
Robert D. Collins, '54; April 1985; Thousand Oaks, Calif.
David N. Leslie, '54; February 8, 1989; San Francisco, Calif.
Archie L. Spratt, '54; December 1988.
Eugene R. Christie, '55; January 17, 1989; Rockville, Md.
Zdlislaw George Wachnik, '56; March 6, 1989; Silver Spring, Md.
MacDonald Barr '57; 1986; Brookline, Mass.
George W. Malaney, '57; August 12, 1988; Nashville, Tenn.
Michael E. Miller, '58; January 25, 1989; Davis, Calif.
Murray S. Watkins, '58; April 9, 1988; Ottawa, Canada.
Nicholas H. Alter, Jr., '61; January 23, 1989; Istanbul, Turkey.
Stephen J. Strauss, '61; November 30, 1988; Port Washington, N.Y.
Michael L. Jablow, '62; January 12, 1989; Tokyo, Japan.
Constantin J. Monego, '67; February 13, 1989; Medford, N.J.
Michael J.R. Levy, '70; January 8, 1989; Gaithersburg, Md.
Byron H. Auker, '72; February 1, 1989; Honolulu, Hawaii.
Jonathan E. Mayo, '80; March 6, 1989; Lowville, N.Y.
Harvey J. Ono, '82; 1985; Chicago, Ill.
Bruce S. McClain, '83; 1988.
Bhaskar Guharoy, '85; March 23, 1989; Belmont, Mass.
William S. Tuleen, '89; March 28, 1989; Bryan, Tex.

ALLAN J. GOTTLIEB, '67

Royal Wedding

Since it has been a year since I reviewed the criteria used to select solutions for publication, let me do so now.

As responses to problems arrive, they are simply put together in neat piles, with no regard to their date of arrival or postmark. When it is time for me to write the column in which solutions are to appear, I first weed out erroneous and illegible responses. For difficult problems, this may be enough; the most publishable solution becomes obvious. Usually, however, many responses still remain. I next try to select a solution that supplies an appropriate amount of detail and that includes a minimal number of characters that are hard to set in type. A particularly elegant solution is, of course, preferred. I favor contributions from correspondents whose solutions have not previously appeared, as well as solutions that are neatly written or typed, since these produce fewer typesetting errors.

Problems

JUL 1. Robert Bart offers a problem he attributes to Robert Darves in which South is to make seven spades with the assistance of all four players.

North
♠ 8 5
♥ Q 9 7 6 5 4 2
♦ 5
♣ 4 3 2

West	East
♠ K 10 7 4	♠ Q 9 6 3
♥ K J 6	♥ A 10
♦ J 10 3	♦ A K Q 4
♣ A Q 10	♣ K J 9

South
♠ A J 2
♥ 3
♦ 9 8 7 6 2
♣ 8 7 6 5

JUL 2. As noted below, problem F/M 4 was misprinted (sorry). Here is the corrected version. *A* offers to run three laps while *B* does two but gets only 150 yards into his third lap when *B* wins. He then offers to run four laps to *B*'s three, and quickens his pace in the ratio of 4:3. *B* also quickens his pace, in the ratio of 9:8, but in the second lap falls off to his original pace, and in the third goes only 9 yards for the 10 he went in the first race. *A* wins the race by 180 yards. How long is each lap?

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

JUL 3. A Cryptoquiz from David Wagner:

PNUIU HC QGSL KIQFUO EUPNQO QY JCCHCPHGA PNU JOFJGRUEUGP QY KZIU CRHUGRU - PNJP QY KHRBHGA EUG QY AUGHZC, DJRBHGA PNUE NUJFHSL, JGO SUJFHGA PNUE PQ OHIURP PNUECUSFUC.

MJEUC DILJGP RQGJGP

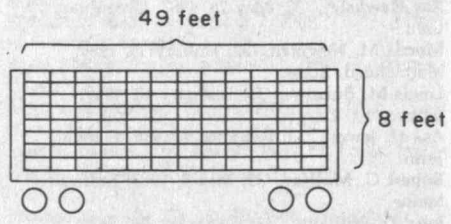
JUL 4. Matthew Fountain has been looking at "constellations," a subject previously studied by Euler. Fountain wants us to find eight distinct positive integers such that

$$A + B + C + D = E + F + G + H$$
$$A^2 + B^2 + C^2 + D^2 = E^2 + F^2 + G^2 + H^2$$
and
$$A^3 + B^3 + C^3 + D^3 = E^3 + F^3 + G^3 + H^3$$

JUL 5. Walter W. Hill and Walter L. Hill (no kidding) want to know the probability that at least one marriage occurs in a normal deck of 52 cards. A marriage is said to occur if a King and Queen are consecutive, e.g., the King of clubs is the 13th card and the Queen of hearts is the 14th.

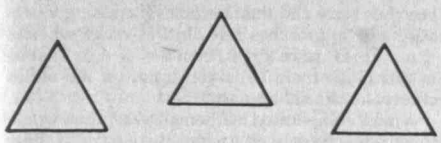
Speed Department

SD 1.



Jim Landau has a "bulkhead flatcar" that he has loaded with finished 2 × 4's as shown. If the lumber-carrying region of the car is 49 feet long and 8 feet high, how many 2 × 4's can the car carry?

SD 2.



The figure shows three triangles made from matchsticks. Nob. Yoshigahara wants you to move two matches so that no triangles remain.

Solutions

F/M 1. We begin with a bridge problem from Doug Van Patter:

North
♠ A K 5
♥ Q 4 3
♦ 7 5 4 2
♣ 8 6 5

South
♠ 7
♥ A K 10 8 6 2
♦ A K 3
♣ A 7 4

Over-optimistic bidding has led to an unlikely six heart contract. West leads the club king, which you take with the ace. When you cash the ace and king of trumps, West shows out on the second round, leaving East with the Jack. How do you proceed? If you were in a four heart contract (duplicate bridge) what line of play would you adopt?

The following solution is from Matthew Fountain: I would play my A, K of diamonds; dummy's A, K of spades while discarding my 3 of diamonds; trump a diamond lead from dummy; enter dummy with trump queen; lead a diamond and discard a club; cash my last two trumps; and concede the last trick. I figure to lose as many as three tricks if East trumps my diamond A or dummy's spade K, four tricks if East trumps my diamond K or dummy's spade A, or two tricks if defender's diamonds do not break three-three. With nine spades out I feel secure that East will not trump the first two spade leads. My probability of being set three tricks is the same as the probability that East holds one or two diamonds at the start of play, as I would change my play if he didn't follow suit at the first play of diamonds. The probability of East holding one or two diamonds is 117/323. East's probability of holding three diamonds, which allows me to make the slam, is 120/323.

At duplicate I would play the same. I understand that to win you must take chances. If you play conservative you'll always end up in the middle of the pack. It is better to adopt a style of play that makes your results swing more wildly up and down. You'll win more prizes or points toward titles that way. But this is just my conception as I have never played duplicate.

Also solved by Joe Feil, Thomas Harriman, Winslow Hartford, Jerry Grossman, and the proposer.

F/M 2. Nob. Yoshigahara sent us a problem from Y. Kotani. For each positive interger n, consider writing the integers from 1 to n inclusive and let $f(n)$ be the number of times the digit 1 was used. For example $f(3) = 1$, $f(10) = 2$, and $f(12) = 5$. Clearly $f(1) = 1$; what is the smallest $n > 1$ with $f(n) = n$?

The following clear analysis is from Bill Cane. By inspection, $f(1) = 1$ and $f(9) = 1$. Consider the numbers from 10 to 99. They fall in two groups: those that start with 1 (10-19), and those that don't (20-99). The ten numbers that start with 1 contribute 10 ones to our function plus the same number of ones as that found from 1-9, which is $f(9)$, or 1. Hence, $f(19) = f(9) + 10 + f(9) = 12$. Those numbers that don't start with one are actually eight groups (20's, 30's, . . .), each of which has the same number of ones as the group 1-9 ($f(9)$, or 1). Together, these eight groups contribute 8 ones to our function, so $f(99) = f(19) + 8f(9) = 20$. Similar reasoning shows that the following progression will obtain:

$f(199) = f(99) + 100 + f(99) = 140;$
$f(999) = f(199) + 8f(99) = 300;$
$f(1999) = f(999) + 1000 + f(999) = 1600;$
$f(9999) = f(1999) + 8f(999) = 4000;$
$f(19999) = f(9999) + 10000 + f(9999) = 18000;$
$f(99999) = f(19999) + 8f(9999) = 50000;$

and, finally,

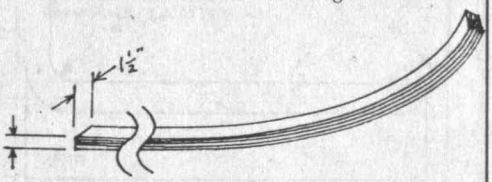
$f(199999) = f(99999) + 100000 + f(99999) = 200000!$

Now consider 199,981. The numbers from 199,982 – 199,999 all contribute a single one to our function, except for 199,991, which contributes 2. Since there are 18 of these numbers, their total contribution to our function is 19, so we can say $f(199,981) = f(199,999) - 19 = 200,000 - 19 = 199,981$. Note that 199,981 itself contributes 2 to our function, so $f(199,980) = 199,979$. Further, all numbers from 100,000 – 199,979 each contribute *at least* 1 one to our total. Therefore, as we proceed back from 199,981, the function must decrease by at least 1 per number. We know $f(99999) = 50000$ and $f(19999) = 18000$, so there can be no number for which $f(n) = n$ that is any smaller than 199,981.

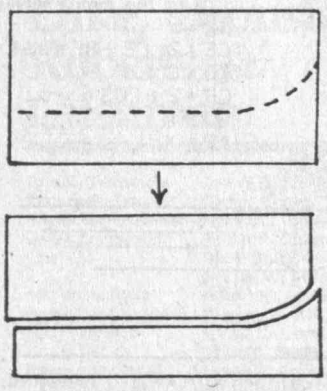
(It can be shown that $f(10^n - 1) = n10^{n-1}$ and that $f(2 \times 10^n) = 10^n + 2f(10^n)$, but I think that simply showing the table used above contributes more to the reader's understanding of the problem.)

Also solved by Gordon Rice, Harry Zaremba, Randall Whitman, Thomas Harriman, Winslow Hartford, Robert High, Matthew Fountain, Steven Feldman, Avi Ornstein, Peter Groot, Alan Taylor, and an anonymous contributer.

F/M 3. Clifford Cantor, from Anchorage Alaska, asks our first ever dogsled-theoretic problem. My brother Jim is laminating together four thin layers of hickory to make a new runner for his dogsled. Each piece is 0.25" thick, 1.5" wide, and about 8' long. The four pieces will be laminated to form a 1" thick runner that will look something like this.



He wants to make a 2-piece mold for gluing the strips together. He plans to cut an 8' sheet of plywood 1.5" thick, so the cut edges will be the surfaces of the mold.



He called me to ask whether he can produce both pieces with a single saw cut. I told him he could not. Was I right? If not, what curve would have the requisite properties?

Norman Spencer solved this one and then wrote: Along with regular Bridge problems, are we now going to see regular challenges to a basement woodworker? My wife has trouble enough understanding

why I make so much sawdust in the basement, but watching me work on this problem convinced her of my derangement. Thanks for the fun.

Mr. Spencer's solution follows:

We are asked to design a mold for a laminated dogsled runner with a ski-tip front, with the limitation of a single cut across a sheet of plywood to form the two halves of the mold. The runner is 1" thick.

In Bruce Hoadley's *Understanding Wood*, we are told that the deformation resulting from successful steam-bending is mostly compression of the concave side, with negligible lengthening of the outer curve. It follows that the geometric problem posed is that the inner-mold requires a radius of curvature of one inch less than the outer curve at any radial position. I assume that the runner is straight for most of its length and the front ski-tip curve covers no more than 90° of arc.

For a mathematically simpler solution, make the infinitely thin band-saw cut as drawn in Fig. 1 to form a ski-tip front with constant radius of curvature. The angles of the arcs at either end of the cut are equal, and are defined by the design. The mold functions by flipping the upper half onto its reverse side shifting it to the left by up to one-inch, and forming the ski-tip at the right side. The left hand curved portions of the mold are non-functional, but will the molds fit? That is, will the tighter curve on the left end of the lower mold overlap the upper mold once the upper half has been flipped and positioned one inch above the lower half?

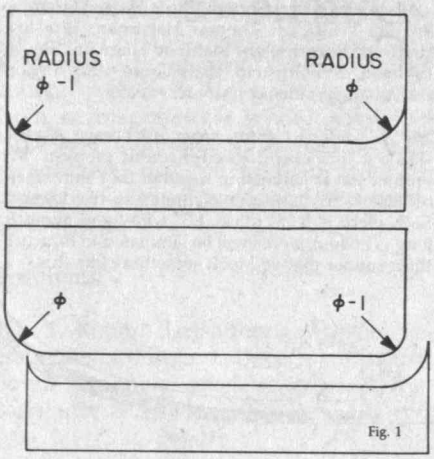


Fig. 1

Let the angular arc of the mold curve at each end be α. See Fig. 2.

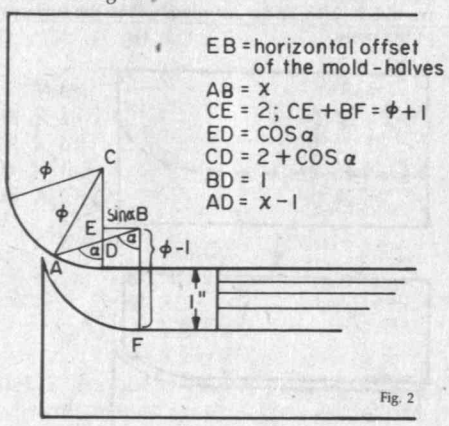


Fig. 2

The molds will fit only if $0 \leq x \leq \phi - 1$, or restated, $x + 1 \leq \phi$. Necessarily, $\phi > 1$

From the Law of Cosines for triangle ACD:

$\phi^2 = (2 + \cos\alpha)^2 + (x-1)^2 - 2(2 + \cos\alpha)(x - 1)(\cos[180 - \alpha])$ (1)

Then $(x = 1)^2 \leq \phi^2$ can be combined with (1) and reduced to:

$x \leq (4 - \cos^2\alpha)/(4 - 4\cos\alpha - 2\cos^2\alpha)$ (2)

For $\alpha = 90°$, $x \leq 1$ which requires $1 \leq \phi - 1$ and $2 \leq \phi$

As α decreases, x increases, and therefore ϕ must increase. At about $\alpha = 43°$, the denominator in (2) becomes zero, and then becomes increasingly negative as α approaches zero. In this range where $0 < \alpha < \pm 43°$ since $x < 0$, then $0 < \phi - 1$. That is, in this range there is no constraint on the radius chosen for the ski-tip design.

A more complicated mathematical solution would involve segments of an Archimedean spiral at either end, rather than segments of a circle. This spiral is chosen because the change of radius of curvature is linear with respect to the change of angle of arc. Therefore, the absolute amount of change of radius along the inner mold is the same as the amount of change of radius along the outer mold arc of the same angle. In order for the tail end of the flipped mold-half to fit, the inner curve must again clear the outer curve. The constraints on the possible arcs or ranges of radii of curvature are beyond my analytic ability.

A final possibility circumvents the mathematical interest of the problem. Cut the required shape in any reasonable location across the plywood sheet using a one-inch diameter router bit. This will require a curve without any discontinuities in the rate of change of radius of curvature along the runner, and with a minimum one half inch radius of curvature at any point. The two mold halves are used in the position from which they are cut and there is no nonfunctional part of the mold.

Also solved by Bruce Brittain, Matthew Fountain, Winslow Hartford, Thomas Harriman, Doug Milliken, Fred Furland, Ken Rosato and the proposer.

FM 4. Charles Piper takes us from dogsled runners to the human variety with a problem he believes dates back to a circa 1850 book *Exercises in Algebra*, by Jones. *A* offers to run three laps while *B* does two but gets only 100 yards into his third lap when *B* wins. He then offers to run four laps to *B*'s three, and quickens his pace in the ratio of 4:3. *B* also quickens his pace, in the ratio of 9:8, but in the second lap falls off to his original pace, and in the third goes only 9 yards for the 10 he went in the first race. *A* wins the race by 180 yards. How long is each lap?

Unfortunately, as printed the problem has no solution. Harry Zaremba has impressed me again, this time by finding this very problem in "Puzzle Corner" a dozen years ago (it did not look familiar to me!) where it was stated correctly. The corrected version appears in the problem section above.

Also solved by Ken Rosato, Thomas Harriman, Randall Whitman, Fred Furland, Matthew Fountain, Linda Kalver, Winslow Hartford, Gordon Rice, Avi Ornstein, Joel Feil, and the proposer.

F/M 5. By analogy with palindrome, a validrome is a sentence, formula, relation or verse that remains valid whether read forwards or backwards. For example, relative to (prime) factorization, 341 is a factorably validromic number, since $341 = 11 \cdot 31$, and when read backwards gives $13 \cdot 11 = 143$, which is also correct. What is the largest factorably validromic number you can find? Remember that 1 is not prime so $n = n \cdot 1$ is not valid.

Peter Groot offers:

$77070000001219201000000 1101 = 70000000001101 \cdot 11010000000001.$

The proposer, Albert Mullin, first defines R_n as the base 10 number consisting of n 1's. For example, $R_3 = 111$ Mullin then notes that R_{1031} has been shown to pass probabilistic tests that make it very likely that it is prime. Finally, Mullin offers as his answer

$$R_{1031} \cdot 101 = 1122\cdots2211$$

Robert High found some (smaller) solutions like the above but then added

What one really would like to find are those rare examples of non-palindromic numbers **none of the prime factors of which are themselves palindromic**, which are factorably valindromic. The *smallest* example of such I found is:

$1469 = 13 \times 113$; $9641 = 31 \times 311$

some other examples are:

$12769 = 113 \times 113$; $96721 = 311 \times 311$

$13273 = 13 \times 1021$; $37231 = 31 \times 1201$

15899 = 13 × 1223; 99851 = 31 × 3221
115373 = 113 × 1021; 373511 = 311 × 1201
124639 = 113 × 1103; 936421 = 311 × 3011
135713 = 113 × 1021; 317531 = 311 × 1201
392899 = 13 × 30223; 998293 = 31 × 32203

998293 is the largest such "non-trivial" factorably valindromic number I found under 1,000,000. Note the special property of the pairs [113,311] and [1021,1201]: **all four** pairwise products 115373, 135713, 317531, and 373511 are factorably valindromic! It would be nice to find a set of four primes such that all *six* pairwise products were non-trivial factorably valindromic numbers, but that may be asking too much. I haven't found any non-trivial factorably valindromic numbers with three or more prime factors either, but I only searched up to 1,000,000. (Including what I call the trivial cases, I found a total of 995 factorably valindromic numbers under a million.)

Thomas Harriman agrees and writes:
Aesthetically each prime factor should be a different number when reversed, and the factors should be different from each other in either order—even though these conditions were not imposed in the original statement of the problem.

First of all, the largest primes discovered are of the form $2^p - 1$, where it's necessary but not sufficient that p be prime, and their only possible factors are of the form 2kp + 1 where k is a positive integer (Fermat, 1640). (The prime requirement and the factor limitation are what made the search for & testing of huge postulated primes feasible, and the record to date is for p = 19937.) But the likelihood that two such primes create the reverse of their product when they themselves are reversed is very small. Further, for the purposes of the problem, they must also be prime when reversed and there are no helpful formulas for limiting the search for reversible primes. Accordingly we're on our own.

It's obvious that to be reversibly prime the factors must begin and end with any of the digits 1, 3, 7, or 9. If what's in between is all zeroes then the product of two such factors will always be the reverse of the product of the reversed factors, provided that the four individual products of the beginning and ending digits are less than 10 and that the sum of the interior and exterior products are also. In other words, A00BxC00D = [AxC]x1000000 + [AxD + BxC]x1000 + [BxD] and similarly for the reverse: when each of the expressions in brackets results in a single digit, reversibility is satisfied. (Reversibility can occur by luck in other ways but not dependably.)

But all zeroes in the middle would leave us with two few numbers among which to find some primes. Use of 7 and or 9 as the beginning digit for one factor doesn't allow much flexibility for the internal digits even when 1's are used for the other three beginning & ending digits. On the other hand, factors of the form 3nnnnnnnn1 allow a reasonable quantity of 2's and 1's as well as 0's to be used as interior digits while maintaining reversibility. The range of possibilities is given by the following pairs of factors representing the upper ranges of values with reversibility.
(3322222221) (3001000001): central 1 may move to right
(3322221111) (3010001001): central 1's may move to right
(3321111111) (3011010001): same as above without bunching

As a practical matter four reversible primes of the lefthand type were found: 3322201021, 3322012021, 3322000001, and the largest given below, without invetigating numbers less than the third one. (This result conforms pretty well to the prime number theory that the quantity of primes up to a given number is equal to the natural log of the number.) Two of the righthand type were found without really trying: 3021000001 and the one given below.

The largest reversible product found with reversible prime factors, limited essentially by the power of a ten-digit TI Programmable 59, is:
(3322221011) (3010000001) = 9999885246432221011
(1101222233) (1000000103) = 1101222346425889999

Also solved by Ken Rosato, Harry Zaremba (who offers the conjecture that there is no largest factorably validromic number), Winslow Hartford, and Matthew Fountain.

Better Late Than Never

1988 M/J 2. Dave Mohr notes that in "correcting" his spelling of *The Compleat Strategyst* I actually converted it from correct to wrong. Although Mohr graciously assigned the blame to my automatic spelling checker, *mea culpa*.

1989 JAN 1. Lyndon Tracy and Hiroshi Yabe have responded.

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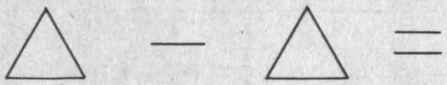
SD 1. 10,752. A finished 2 × 4 is 1.5 inches by 3.5 inches.

SD 2.



DONOR'S PROFILE:

MR. WILLIAM K. CUTTEN

HOME: Allentown, Pennsylvania

CAREER: A retired major in the U.S. Army, Mr. Cutten received an SB in Mining and Metallurgy from MIT in 1939 and an SM in General Engineering in 1941. He worked for DuPont, Western Electric and Burlington Industries, advancing to senior project engineer. His father, Leverett H. Cutten '07, was the creator of the MIT Mace, which is carried at Commencement by the Chief Marshall.

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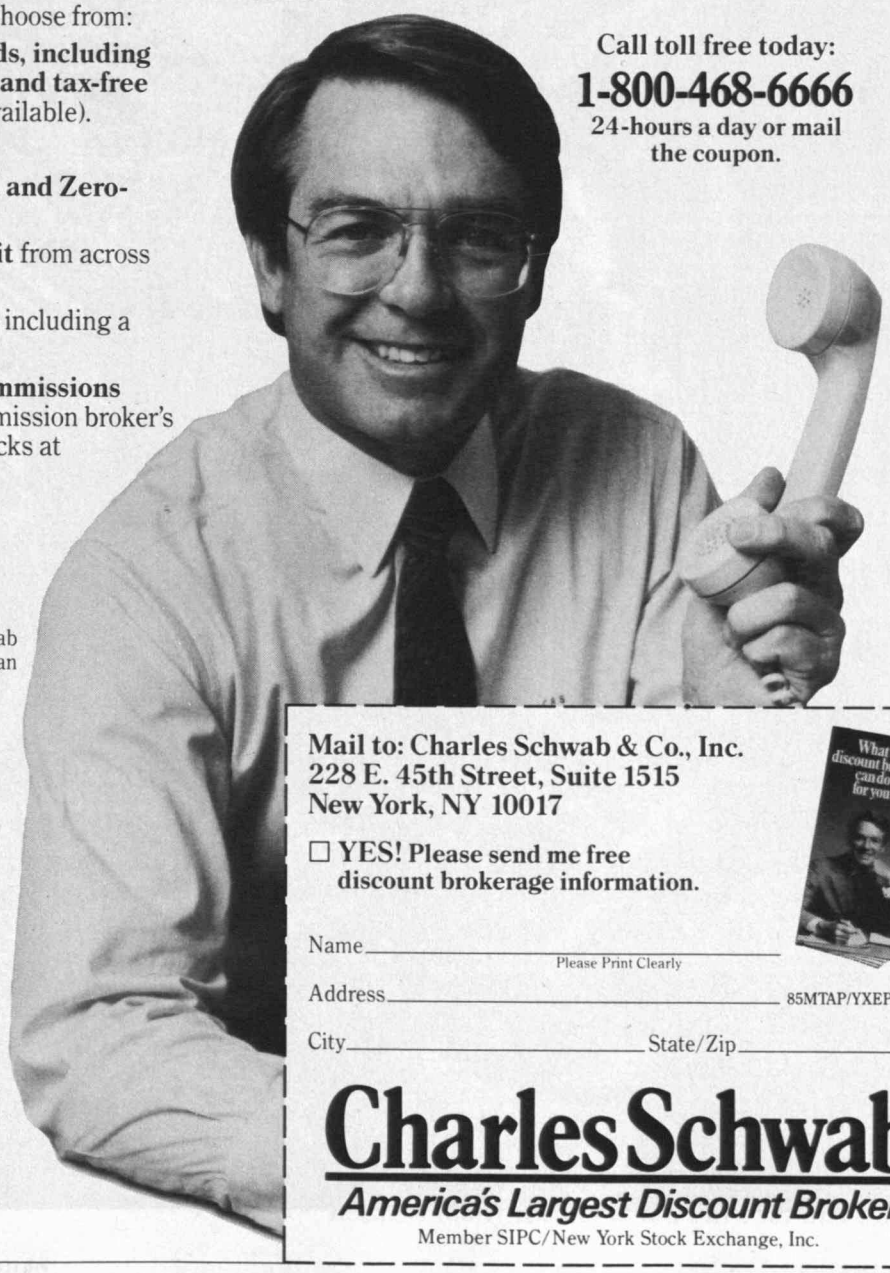

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BY WILLIAM SWEET

Chernobyl
What Really Happened

Soviet technical fixes adopted since Chernobyl don't eliminate the possibility of a recurrence—and may make one more likely.

THREE years after the April 1986 nuclear catastrophe at Chernobyl, this is an opportune time to take stock of the accident, the technical measures the Soviets have taken to improve reactors like those at Chernobyl, and the implications of the accident for other types of reactors. As the shock of the accident has been absorbed, Western experts have become noticeably more willing to voice their concerns, air disagreements about technical issues, and state the truth exactly as they see it.

Soviet officials turned immediately to reactor experts in the West for advice. The Soviets made a remarkably full disclosure of their knowledge about the accident at a September 1986 meeting held under the auspices of the International Atomic Energy Agency in Vienna. During the next two years, they invited at least a dozen outside experts to come to the Soviet Union for a firsthand look.

Until recently, however, the Western analysts talked mainly with each other, and when they reported their findings in official reports or in articles for the public, they tended to couch their conclusions in cautious bureaucratic language. Obviously, they did not want to jeopardize their delicate relations with the Soviet Union and embarrass their hosts. And they were wary of the impact their statements would have in their own countries.

That reticence has declined with time. To get a snapshot of current expert opinion, I conducted extensive interviews with staff members of the Nuclear Regulatory Commission (NRC) who studied the accident, two former NRC commissioners, members of a Department of Energy (DOE) study team, leading Canadian reactor experts, and scientists from industry, academia, and national laboratories.

What follows represents an effort to reach a consensus view of the accident. The central conclusion is that a runaway nuclear reaction set off a chain of events that severely damaged the reactor core and surrounding structures. This damage set the stage for a second explosion, which was much more violent than the first and almost certainly was a full-fledged nuclear explosion.

Because many factors could have set this chain of

A technical crew monitors radiation levels over Unit 4 soon after it exploded.

events in motion, the technical fixes adopted by the Soviets do not preclude the recurrence of an equally catastrophic event at a Chernobyl-type reactor. Some of the fixes may even increase the probability of a future catastrophe.

Ever since the first nuclear power plants were built in the 1950s, the industry has insisted they can't explode like bombs. Chernobyl casts doubt on whether that is true of all power reactors. Of the plants operating in North America, however, only the Canadian plants are susceptible to a Chernobyl-type accident.

The possibility of such an accident in a U.S. reactor is vanishingly small. Here, the worst-case scenario envisages that a loss of coolant would lead to a buildup of heat because of continuing reactions in the fuel. The fuel would melt and burrow through the plant bottom into the earth.

The Chernobyl accident was fundamentally different. After the coolant was lost, or some equally serious event occurred, nuclear reactions escalated rapidly and uncontrollably. They kept doing so until the plant's structure disassembled—that is, until Chernobyl Unit 4 exploded.

The RBMK Reactor

The Chernobyl reactor is an RBMK, which is a derivative of the reactors built to produce plutonium for the first Soviet atomic bombs. Since those plants were military machines, public and occupational safety received relatively short shrift in their design. While the United States sought from the outset to assure civilian control of nuclear technology, and established the NRC in the early 1970s to independently regulate power reactors, Soviet development of both plutonium and power reactors remained under narrow bureaucratic authority until after Chernobyl. As a result, the Soviets designed a reactor that never should have been built, and they failed to familiarize its operators adequately with its defects.

The RBMK is a graphite-moderated, water-cooled reactor, built to be fueled while running. The reaction is driven by neutrons released as uranium atoms split. The uranium fuel is arranged in pins that are contained in 1,661 zirconium-alloy pressure tubes, which are imbedded vertically in a 2,000-ton pile of graphite blocks. The graphite slows down neutrons released by uranium fission, enhancing their ability to induce more additional fissions so the reaction can sustain itself.

Water, pumped up through the pressure tubes, comes to a boil in the middle of the pile, and steam is carried off to the turbine systems that generate electricity. Control rods penetrating the pile regulate the reaction rate—that is, the power level—by capturing neutrons and damping the unit's reactivity.

One of the RBMK's principal defects is that it tends to gain power rather than slow down when water is lost or converts to steam. In all the reactors licensed to operate in the United States, the fission

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PHOTOGRAPH: EOSAT COMPANY

Far left: Three days into the accident at Chernobyl, color-enhanced satellite photos depict Unit 4 as a glowing hot spot (A). Also visible are Units 1 and 2 (B), as well as the site where the Soviets probably were building more reactors of the same type (C).

Left: Like Unit 4, Unit 1 was an RBMK reactor. The photo shows Unit 1's control board in June, two months after the Unit 4 disaster.

rate slows if water is lost, so the system tends to be self-correcting. In the RBMK, fissions increase if water converts faster than expected or if there is a sudden leak.

This highly undesirable feature, called a positive-void effect, can make the reactor go out of control. The effect is especially strong if the RBMK is operating at low power. Ironically, the reactor is much more prone to go out of control when it has been in operation for a long period of time and the fuel is relatively depleted.

Aggravating the risks of the positive-void factor is the fact that the unmodified RBMK has a slow and perversely designed control-rod system. As Chernobyl revealed, that system could not be counted on to respond quickly enough to sudden changes in reactivity, and inserting control rods might even increase rather than dampen reactivity.

A third major design defect is the RBMK's inadequate containment. The containment system is predicated on the dubious assumption that the worst-case accident would result from a rupture of a single major water pipe at the bottom of the pile, where water is pumped up through the pressure tubes. Thus, the designers compartmentalized the bottom of the reactor, and the newer versions of the RBMK have a pool underneath. In the event of a tube rupture in the lower part of the reactor, the pool condenses steam, prevents pressure from building up too high, and captures water contaminated by damaged fuel.

The top of the reactor, however, is left relatively defenseless in all the RBMKs built or under construction. While a gigantic steel slab weighing about 1,000 tons seals the top of the reactor, all the pressure and control tubes penetrate this cap. Surprisingly little pressure can lift it, breaking all the pressure tubes and destroying the control mechanism. No kind of containment surrounds the tube, control, and refueling systems at the reactor's top, so if it lifts, radioactive and irradiated materials escape directly into the poorly sealed building and hence into the environment.

According to a calculation by Herbert Kouts at Brookhaven National Laboratory, 6 pounds per square inch (psi) would lift the lid. A rupture of just several of the 1,661 tubes would dump enough boiling liquid into the reactor to exert 1,000 psi.

The Accident

The immediate events surrounding the destruction of Chernobyl make sense only if it is appreciated that the RBMK was designed to run at virtually full capacity for a year, whereupon it would be shut down for maintenance. Thus, the reactor is designed to face its worst self only when fueled for the first time and twice a year after that, as it is taken out of and put back into service.

At the first fuel loading, problems arise from the fact that "the large enriched uranium fuel load creates many critical masses in the core," as an NRC report puts it. "The control rod system alone is not sufficient to hold the core subcritical for the initial fuel loading. . . . [Therefore,] one supplemental absorber rod is loaded for every six uranium-fueled channels."

When the reactor comes out of operation for annual maintenance and again when it is restarted, it passes through the vulnerable low-power zone in which the positive-void factor is most dangerous. The situation would be particularly risky at shutdown, when the positive-feedback mechanism is even more potent because of high fuel burn-up.

April 25 was the eve of this annual maintenance period. As the crew took the reactor down, they were preparing to test whether residual flywheel energy in the turbines could provide temporary electrical power to control the plant if the reactor lost outside power. Evidently, because of an exceptionally good operating record, the crew members were cocky. And apparently because this test could be performed only during the annual shutdown, they were deter-

PHOTOGRAPH: SOVFOTO

If the second explosion was nuclear, it would be deeply misleading to say that Chernobyl did not blow up like an atomic bomb.

mined to get it done. They therefore took a large number of reckless measures that disabled safety systems and put the reactor into its most unstable state.

"The presumption that this was an electro-chemical test with no effect on reactor safety seems to have minimized the attention given to it in safety terms," a report by the International Atomic Energy Agency (IAEA) concluded. "Authority to proceed was given to the station staff without the necessary formal approval by the station safety technology group. . . . The test could have and should have been conducted in such a way that the reactor tripped [shut down] when the test began."

Instead, when the reactor started to lose power before the operators were ready to begin the test, they disabled safety systems in an effort to keep the reactor operating. When the reactor was on the verge of shutting down spontaneously before the test had been completed, they removed virtually all the control rods, boosting the positive-void coefficient to about 1.5 times its normal value. As a result, the fuel load or some part of it went out of control. In less than a second, the reactor's power went from nearly zero to perhaps 50 to 100 times the plant's maximum rated capacity. Fuel melted and interacted with water and steam, and some fuel probably vaporized. Enough pressure was generated to lift the reactor lid, rupturing all the pressure tubes and control rods.

Descriptions of this initial explosion in the official literature differ significantly in nuance. All refer in some fashion to a steam explosion, but in one way or another they also make clear that a runaway nuclear reaction was the driving force. At least one report seems to suggest that this reaction alone may have sufficed to blow up the reactor building.

Treading cautiously, the NRC report says, "Within the context of a very strong power pulse, the Soviets could visualize an intense fuel/coolant interaction, i.e. a steam explosion."

The IAEA report, based on the evidence and analysis presented by Soviet experts, makes a somewhat more confident assessment: "The continuous reactivity addition by void formation led to a superprompt critical excursion." A superprompt critical excursion is a nuclear reaction that by definition will stop only when the reacting substance blows itself into pieces.

In its report, the Organisation for Economic Cooperation and Development (OECD), which in-

The consensus is that improvements in RBMK reactors will reduce but not eliminate dangers from the "positive-void effect."

cludes most developed nations, calls the event a "reactivity-driven steam explosion." But elsewhere the same report casts doubt on whether a steam explosion took place at all: "The evidence that a steam explosion occurred during the Chernobyl accident is largely circumstantial although it is generally given as an accepted explanation of the damage observed."

The Second Explosion

According to eyewitness accounts and evidence presented by the Soviets, a second explosion occurred seconds after the first. Characterizations of this one are even more ambiguous. Some reports steer clear of the second explosion and barely mention it. The IAEA says it is unclear whether it was a second nuclear excursion or a chemical explosion resulting from the reaction of air with hydrogen freed by interactions between zirconium and water. The NRC says the second event, if it occurred, may have followed the plant's destruction and might have been a second nuclear excursion, a hydrogen explosion, or even an echo.

How to describe the second explosion was a sore point that divided NRC and Department of Energy researchers when they tried to collaborate on a joint report. The DOE group was much more cautious about the precipitating causes of the accident but quite certain that the second explosion was a pure nuclear excursion. The group's view was and is that this explosion was much more powerful than the first, and that it was this explosion that completed the destruction of the plant and blew parts of its core into the upper atmosphere.

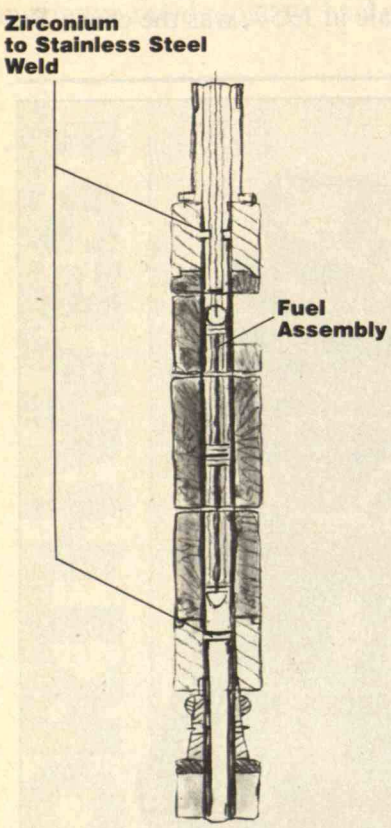
DOE's position is based on Soviet data and calculations contained in the IAEA report and presented as a graph insert to the report (*see chart on page 49*). These calculations indicate that the second explosion took the reactor to 400 to 500 times its normal maximum power. The figures are predicated on roughly this interpretation: the first explosion caused the core and surrounding structure to disassemble; and the core or some part of it reconfigured itself, formed into a critical mass, and exploded like a bomb.

When news of the Chernobyl disaster first reached the West, experts speculated that a graphite phenomenon, which had led to the destruction of a British reactor at Windscale in 1957, was the cause. But

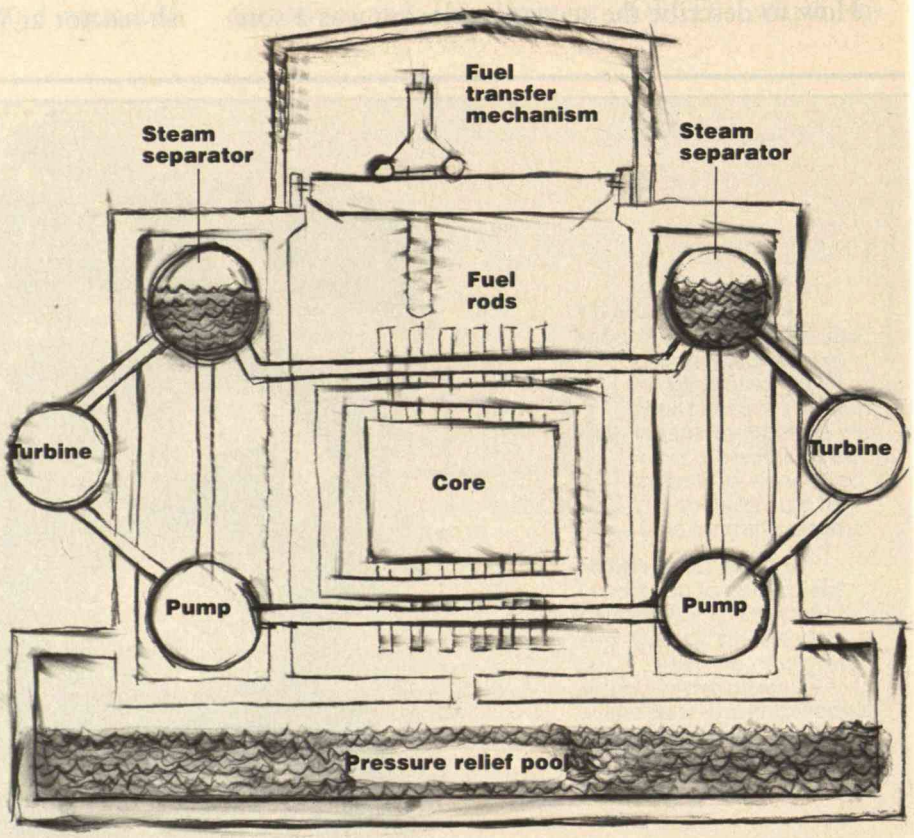
Right: In RBMK reactors, all the control and fuel rods penetrate the top. Surprisingly little pressure can lift this lid, breaking the rods. Here, a worker checks the top of Chernobyl Unit 1 in June 1986.

Below left: The design of RBMK fuel rods may be seriously flawed. Abrupt temperature changes could break the sensitive weld that joins an inner zirconium-alloy section to outer steel sections.

Below right: RMBK reactors recirculate water continuously. Pumps on both sides of the central building send water up the fuel rods so the heat turns some of it to steam. Separators then send the water back to the pumps and divert the steam to turbines that generate electricity. In the turbines, the steam recondenses into water, which returns to the pumps.

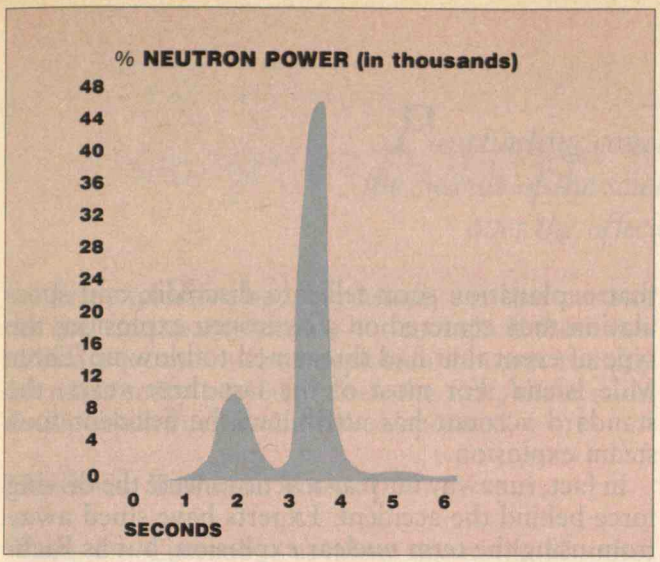


Fuel channel



Chernobyl-Type Reactor

PHOTOGRAPH: SOVFOTO; ILLUSTRATIONS: DAVID SCHUSTER



Left: Soviet calculations of Chernobyl Unit 4's behavior during the accident suggest that two explosions rocked the plant.

Left: While other RBMK reactors continue to operate in the Soviet Union, Chernobyl Unit 4, contaminated with radiation, will remain buried for centuries in a sarcophagus.

PHOTOGRAPH: SOVFOTO

Canada's Post-Chernobyl Challenge

Canada's CANDU plants are North America's closest operating relatives to the reactor that exploded at Chernobyl.

Of the nuclear power plants operating outside the Soviet Union, only Canada's CANDU reactors have a substantial positive-void coefficient—the design feature that rendered the Chernobyl reactor vulnerable to disaster.

Like the RBMK, the CANDU is fueled while operating, but the Canadian reactor is fueled horizontally so the rods don't penetrate the top, and the fueling mechanism is encased, like U.S. reactors, in a formidable containment structure. Moreover, the turbines are linked indirectly rather than directly to the reactor's cooling system, reducing the risk that pump problems could lead to an abrupt loss of water and bring the positive-void effect into play.

Official Canadian reports describe the CANDU's positive-void coefficient as about one-third that of the RBMK's. Specifically, the reports say that loss of coolant in a CANDU could increase reactivity by 7 to 11 mk (a measure of reactivity), compared to 30 mk in the RBMK. This distinction may be academic, since reactors become uncontrollable at about 5 mk.

More important, Ontario Hydro vice-president William Morrison says reactivity increases much more slowly in a CANDU and its control rods are much faster. Canadian licensing requires reactor designers to assume a worst-case accident in which both coolant is lost and the primary shutdown system fails. Accordingly, all but four aging CANDUs have a second shutdown system that rapidly injects a fission poison into the reactor.

The Canadians point out that every reactor, whether or not it has a positive-void coefficient, is vulnerable to sudden changes in reactivity. For example, Morrison says that suddenly ejecting the control rods from a pressurized-water reactor (one type of water-moderated reactor) will speed up the reaction well beyond the point at which it would be uncontrollable. Zig Domaretski, safety chief at the Atomic Energy Board of Canada, says that every time a turbine disengages in another type of water-moderated reactor, reactivity rises about 10 to 12 mk. Dealing with this is straightforward, he says, requiring a shutdown system that reacts in the first half-second and provides 30 mk of damping within a few seconds.

"Every reactor has the potential for large reactivity increases, but only the RBMK did not recognize this adequately," according to Morrison. Domaretski says the RBMK's shutdown system is satisfactory only when the reactor is at full power, but accident analyses seem to have assumed full power—an "almost incredible attitude." — *William Sweet* ■

that explanation soon fell into discredit, and speculation then centered on a hydrogen explosion, the type of event that had threatened to blow up Three Mile Island. For most of the last three years, the standard account has attributed the accident to a steam explosion.

In fact, runaway nuclear reactions were the driving force behind the accident. Experts have shied away from using the term nuclear explosion, but as Richard Wilson of Harvard University has said, "It was a nuclear explosion, there's no doubt, because the ultimate source of energy was nuclear. . . . To ever say it was not a nuclear explosion is just plain wrong."

First, a runaway reaction caused the fuel to melt and expand. Whether or not interactions with steam or water took place, the pressures would have sufficed to lift the lid. Once that happened and all the tubing ruptured, many conceivable catastrophes might have occurred, and for all we know, they all may have. Probably a second nuclear explosion occurred, much more violent than the first runaway reaction, and this nuclear explosion completed the destruction of the plant's physical structure.

Not every expert, to be sure, believes that the second explosion was nuclear. Brookhaven's Kouts, one of the most respected U.S. reactor specialists, thinks the second event was a particularly violent steam explosion caused by the sudden ejection of tiny fuel particles into the water-steam tubing. Other experts passionately reject this notion of a "superheat" steam explosion.

If the second explosion was indeed nuclear, would it be fair to say that the reactor blew up like an atomic bomb? In one sense, it would be deeply misleading to say that it did. While a bomb is designed to make a critical mass explode in microseconds with an energy measured in millions or billions of gigajoules, the Chernobyl reactor exploded thousands of times more slowly with an estimated energy of perhaps 1,000 gigajoules.

But if the second explosion *was* nuclear, it also would be deeply misleading to say that the plant did not blow up like an atomic bomb. In an explosion of that kind, the reactor would go through the same physical steps the core of a bomb traverses. It would turn into a critical mass and begin to react uncontrollably. The fuel would melt and finally vaporize.

Did the fuel definitely vaporize? The official reports sometimes waffle on this question regarding

PHOTOGRAPH: ONTARIO HYDRO

Punctuating concerns over Chernobyl is the suicide of the scientist delegated to preside over the official Soviet review.

the first explosion, but they usually say that parts of the fuel must have become hot enough. If there was indeed a second nuclear explosion that was roughly 10 times more powerful than the first, there is no doubt at all: fuel would have vaporized.

The Soviet Technical Fixes

When the Chernobyl accident occurred, 13 other RBMK reactors were operating in the Soviet Union, "many with fewer safety features than Chernobyl Unit 4 had," an NRC report observed. A number of other RBMKs were under construction, but their status is now uncertain because of spreading anti-nuclear activism, new concern about seismic dangers in the aftermath of the Armenian earthquake, and—not least—concerns arising from the Chernobyl accident itself. This April, the Soviets abandoned plans to build two new reactors at Chernobyl and announced that they would not expand similar facilities elsewhere.

The Soviets have introduced a number of design modifications to render the RBMKs less vulnerable to the type of accident thought to have destroyed Unit 4. They have slightly increased the enrichment of the fuel, installed stops limiting the extent fuel rods can be removed, and made the control-rod system faster. It is generally believed that operating RBMKs are being retrofitted to these specifications. Experts also suspect that the Soviets may be taking other measures to improve the RBMKs under construction, such as installing more pressure tubes and control rods to reduce the density of the graphite lattice.

The general intent of these measures is to reduce the scope and magnitude of the positive-void effect and enhance the control system's ability to cope with conditions that could lead to a runaway reaction. The consensus among Western experts is that the steps will reduce but not entirely eliminate the positive-void factor, and that they improve control of the rods.

But experts stress that there are strict inherent limits on the extent to which the RBMK can be made safer. And they express considerable concern that the corrective measures do not address all the severe accident possibilities that Chernobyl brought to light. Finally, some experts believe that the corrective measures may even aggravate some risks.

For example, the OECD report points out that richer fuel increases the instability that exists when the fuel is first loaded into the reactor. The speedier control rods could cause still other serious problems. Each RBMK pressure tube has a sensitive weld toward the top and bottom, which joins an inner zirconium-alloy section to outer steel sections (*see the diagram on page 48*). The Soviets were well aware that these welds were vulnerable to sudden temperature changes, according to Kouts. He believes one reason the RBMK had a slow control system was to avoid subjecting the welds to excessive thermal shock.

If control rods were inserted suddenly, causing the temperature of the reactor to change abruptly, there is a serious danger that several of the tubes would rupture. A dozen or so breaks would easily suffice to lift the lid of the reactor, break the tubes and control mechanisms, and precipitate the chain of events that occurred the night of April 26.

In fact, Wilson and some other experts believe that a multiple tube rupture might have actually caused the Chernobyl accident. In this scenario, the accident may have resulted when the operators subjected the reactor to thermal shocks as they sought to stabilize it at a low power level. Whether or not this actually happened, it could have happened. Wilson says that he and others have tried to get the Soviets to focus on this scenario, but the Westerners have had little apparent success.

Because so many factors and combinations of factors could have caused or contributed to the catastrophe, Edward Purvis, who led DOE's study team, has criticized those who endorse a specific explanation. "If you're trying to make the RBMKs safe, you can't arbitrarily pick one thing and fix it," Purvis says. "You have to take care of all possible causes."

The NRC's view of the RBMK is not drastically different. Asked how he would rate the vulnerability of the modified RBMK to catastrophic accident, Harold Denton, the former NRC safety chief, said, "We wouldn't license such a reactor here, and we've told them so."

Soviet authorities have tried to blame the Chernobyl accident primarily on the plant's operators, and the top people responsible for running the plant have been tried and convicted of negligence. But years before the accident, British reactor experts are reported to have told their Soviet counterparts that the flawed RBMK design put excessive demands on the plant operators. It is an open question whether

The top of the reactor is relatively defenseless in all the Soviet units built or under construction.

the modified design represents a significant and adequate improvement.

Meltdowns and Explosions

Chernobyl has implications primarily for the RBMK reactor and secondarily for Soviet management of nuclear energy. U.S. reactors, in which water as opposed to graphite moderates the reaction, are not seriously vulnerable to a Chernobyl-style mishap. A fizzling steam explosion could occur in a U.S. reactor if a molten core dropped into a pool of water, but the possibility is remote, and the result would not be the enormously violent nuclear explosion that destroyed Unit 4.

While the Soviet government has made an unprecedented disclosure of sensitive information, and has displayed an extraordinary willingness to take advice from outsiders, reactor experts in the United States and Canada remain worried about the possible recurrence of a catastrophe in an RBMK reactor. These scientists are unhappy about the reluctance of the Soviets to perform the very detailed accident analyses that came into fashion here after Three Mile Island. And despite the openness to Western criticisms, government censors still routinely excise Chernobyl-related articles from Western publications circulating in the Soviet Union.

Punctuating the continuing concern over RBMK reactors is the suicide of Valery Legasov, the atomic scientist the Soviets had delegated to preside over the official Chernobyl review. He killed himself on April 27, 1988, the second anniversary of the accident, and official explanations of the death are vague. Reliable private reports indicate he had a terminal disease and planned his death in collaboration with a physician, but it is possible that Legasov, by choosing the day he did, also wished to make a public statement with his death.

Certainly it gives weight to his posthumous warnings about the threats that Chernobyl still poses. A month after the suicide, *Pravda* published parts of memoirs that Legasov had dictated into a recorder during the two years after the accident. *Pravda* headlined the excerpts, "It is my duty to speak out."

According to the extracts, Legasov had been aware of deteriorating trends in the design and management of nuclear power plants before the accident, but he had felt powerless to intervene because "professionals in the field did not take kindly to outside interference." The scientist complained that officials had dismissed his calls for rigorous reactor fault analysis and studies of safer reactor types.

While he felt nuclear power plants probably were safer than conventional power plants, Legasov worried about the amount of graphite, zirconium, and water in the RBMK. And he was concerned about the lack of safety systems that would activate independently of operators.

Legasov came to believe that an important underlying cause of the disaster was the absence of individual responsibility for equipment quality. He called the events at Chernobyl the "apotheosis and peak of the economic mismanagement in our country over decades."

Just before his death Legasov told *Pravda,* "The lessons of Chernobyl have still not been analyzed to the end." ■

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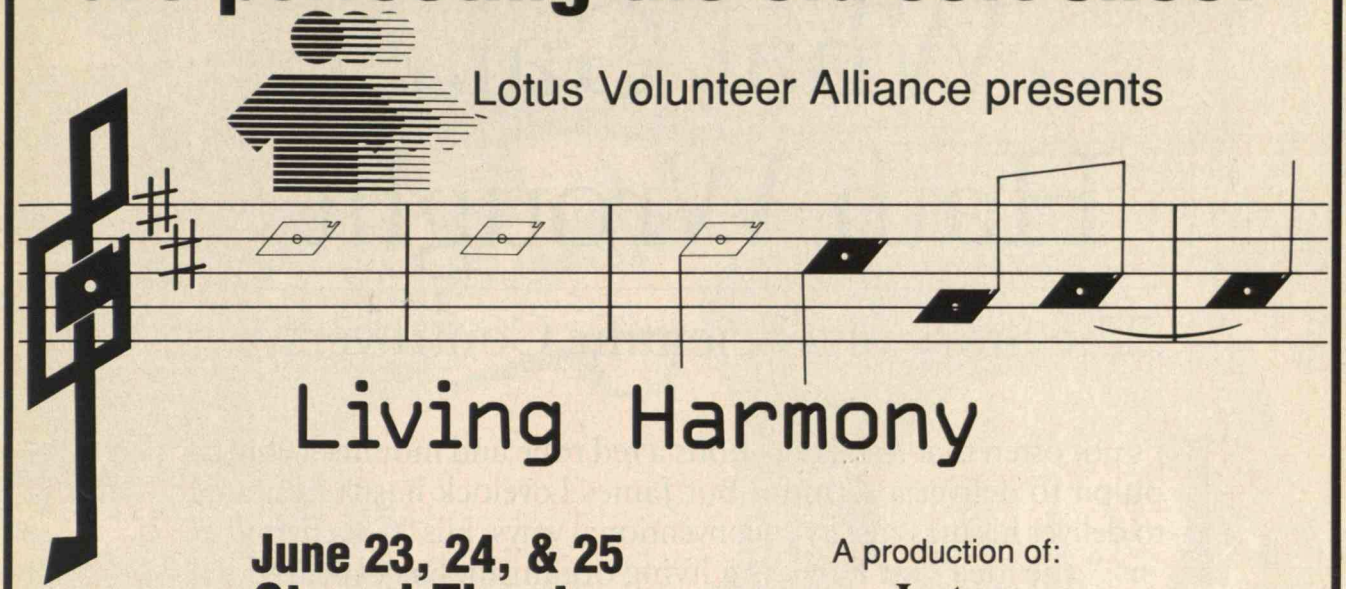

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BY FRANCESCA LYMAN

What Gaia Hath Wrought

The Story of a Scientific Controversy

It's not often that a scientist dons a red robe and mounts a church pulpit to deliver a sermon. But James Lovelock hasn't hesitated to deliver his message in unconventional ways. His "Gaia hypothesis," the idea that Earth is a living organism, has captured the attention of an unusual assortment of people, including industrialists, environmentalists, and members of the New Age movement. And although Lovelock's appeal to non-scientists has increased many colleagues' skepticism about his work, some of his ideas have sparked important research on global climate change.

"How can anything as large and apparently inanimate as the Earth be alive?" Lovelock asked the congregation in New York's Cathedral of Saint John the Divine one Sunday last fall. He answered the question with the metaphor of an old redwood. "It is a spire of lignin 2,000 years old . . . . The tree is alive, yet 99 percent of it is dead." So too, he has written, with Earth. "Just as the shell is part of a snail, so the rocks, the air, and the oceans are part of Gaia."

Gaia, named for the Greek goddess of Earth, is Lovelock's term for the living force that he believes controls the planet, regulating temperature, atmospheric composition, and other physical characteristics. He thinks that biological processes such as photosynthesis are at the heart of the Gaian life force. "Consider how the oxygen and nitrogen of the air come directly from plants and microorganisms," he writes in *Ages of Gaia,* published in November 1988. "Life has not adapted to an inert world determined by the dead hand of chemistry and physics."

A maverick scientist's theory that a living force controls Earth is shaking up his mainstream colleagues.

ILLUSTRATION: MARY JO MAZZELLA

The Gaia hypothesis didn't receive a hearing from the scientific establishment until 16 years after it was proposed.

To many this talk is anathema. Most earth and life scientists believe that, far from controlling the planet, life has simply adapted to physical and chemical processes such as tectonic movement, the hydrologic cycle, and the spewing of gases from volcanoes.

The controversy goes far beyond academia's ivy-covered walls. With the ozone layer thinning, carbon dioxide building up in the atmosphere, tropical forests vanishing, and deserts extending their reach, more and more scientists are worried about the implications for the planet as a whole. "What controls the net effect is the real question," says Penelope Boston, a microbiologist who has started a non-profit laboratory—Complex Systems Research—studying biogeochemical cycles related to the atmosphere. Gaia, she says, is the only proposal that offers a unified sense of the linkages among all the parts of the global ecosystem: the atmosphere, oceans, land masses, and biota. Whether or not the hypothesis proves accurate, it offers a framework for understanding how the pieces fit together.

FRANCESCA LYMAN, who is writing a book on the greenhouse effect, has covered environmental issues for 10 years. She previously edited Not Man Apart, *a magazine published by Friends of the Earth, and* Environmental Action *magazine, published by the Environmental Action Foundation. She started her career reporting for newspapers in New Jersey, where, she says, "you can't work without writing about environmental issues."*

In the early 1970s Lovelock fleshed out the Gaian concept with Lynn Margulis, a microbiologist now at the University of Massachusetts. The idea caught fire in 1974 when they published it in the counterculture magazine *Coevolution Quarterly.* "Although I thought the subject was mainly science," Lovelock writes in *Ages of Gaia,* "two-thirds of the letters received [since my first book on the topic was published in 1979], and still coming in, are about the meaning of Gaia in the context of religious faith."

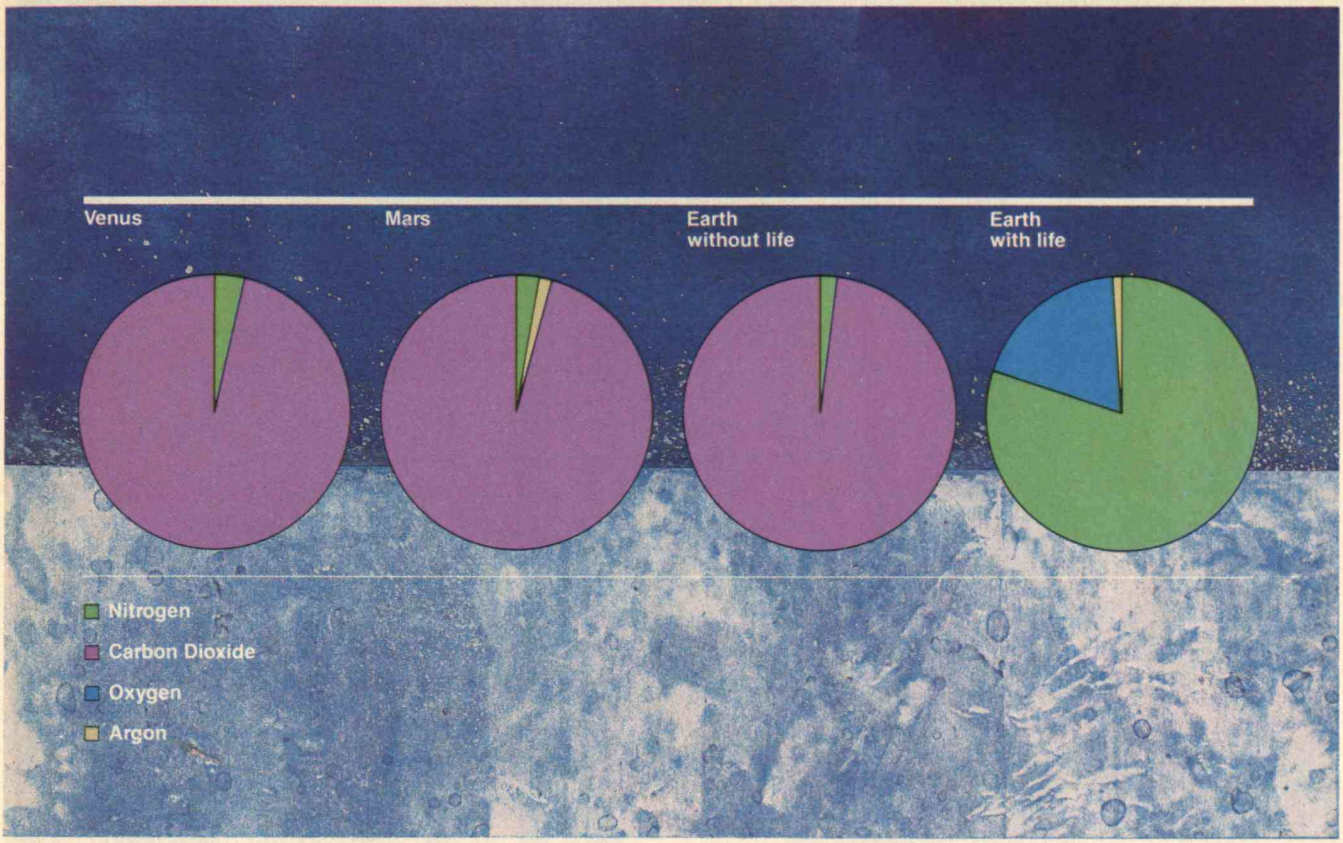
Most scientists dismissed the Gaia hypothesis as more religion than science. Evolutionary biologists such as Richard Dawkins of Oxford University and W. Ford Doolittle of Dalhousie University in Nova Scotia jumped on it for implying too much purpose in nature.

Others attacked the theory because it led Lovelock to maintain that Earth seemed "capable of withstanding major perturbations" from industrial pollution. In 1975, at the height of the debate over spray-can aerosols, which then emitted ozone-depleting chlorofluorocarbons, Lovelock told a National Institute of Health Sciences conference, "We tend to forget that pollution is a way of life of many natural species. Our capacity to pollute on a global scale seems rather trivial by comparison." The chemical industry lost no time in using Gaia to argue that nature will always bounce back.

Not until last year, 16 years after the Gaia hypothesis was first proposed, did it receive a hearing from the scientific establishment, as the subject of the distinguished Chapman Conference, sponsored by the American Geophysical Union (AGU). Stephen Schneider, a climatologist at the National Center for Atmospheric Research who thought scientists had not examined Gaia closely enough, organized the event. There was considerable resistance, comments Schneider, who has himself criticized parts of the theory. "I was condemned as 'embarrassing science by putting on that nonsensical meeting,'" he notes. In the end, though, conferees gave Lovelock a standing ovation. Even critics said he had developed an ingenious way of looking at the world.

The Gaia hypothesis has also started filtering into the mainstream in the guise of "Earth systems science." This new discipline, which spans a range of sciences, stresses the feedback mechanisms among the oceans, atmosphere, climate, geological systems, and biosphere. The need to understand global climate change has pushed the approach into the vanguard of international research. Walter Rosen, a biologist with the National Academy of Sciences, says global change "may be the ultimate test of the Gaia hypothesis."

Lovelock thinks that if there were no life on Earth, its atmosphere would be much more like that of Venus and Mars—consisting almost entirely of carbon dioxide and nitrogen. As it is, nitrogen predominates, oxygen is the second most abundant gas, and the percentage of other gases is lower.



An Uncommon Path

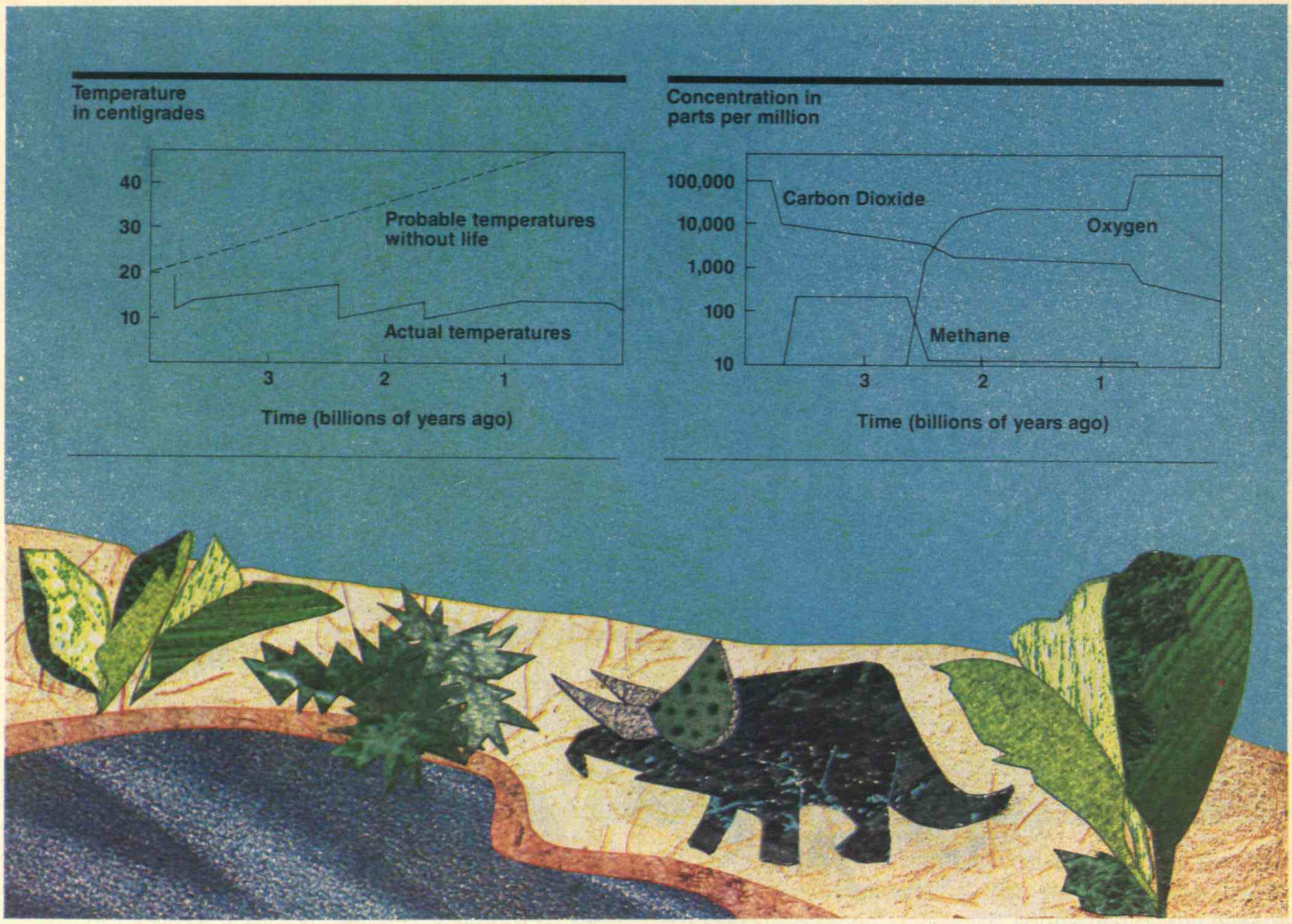
Perhaps Gaia is unorthodox because James Lovelock has chosen to work outside the scientific establishment. A gentle, reflective man with horn-rimmed glasses and a quiet demeanor, Lovelock looks more like the stereotypical scientist than a maverick. Yet his professional path has hardly been traditional. He received an undergraduate degree in chemistry, then a doctorate in medicine after studying physiology—and went on to make his living as a free-lance designer of precision instruments. Today Lovelock holds 60 patents. For years he was best known as the developer of the electron-capture detector, still the finest instrument for analyzing minute amounts of trace gases such as chlorofluorocarbons.

Working out of a laboratory attached to a small mud-and-straw cottage in Cornwall, England—with a bevy of peacocks outside—Lovelock chides most scientists for being beholden to the organizations, universities, and companies that employ them. In a typically playful passage from *Ages of Gaia* he comments, "You may well ask, Whatever became of those colorful romantic figures, the mad professors, the Drs. Who? Scientists who seemed to be free to range over all of the disciplines of science without let or hindrance? They still exist, and in some ways I am writing as a member of their rare and endangered species."

That intellectual freedom has led Lovelock to study a variety of scientists from the past—for example, the eighteenth-century English geologist and physician James Hutton. Remembered as the father of geology, Hutton wrote in 1785 that Earth is a superorganism. Thus, Lovelock says, "Its proper study should be physiology."

Lovelock came upon such ideas after designing instruments and discussing life-detection experiments for NASA's Mars probe project in the early 1960s. He became preoccupied with how the atmospheric composition of Earth differs from that of its neighbors, and decided that any life alters a planet's atmosphere in some way.

To support his contention that organisms have maintained a relatively stable climate on Earth for at least 3.6 billion years, Lovelock's graph on the left compares actual temperatures with what they might have been if no life were present. The "steps" in the line correspond roughly to the changes in carbon dioxide, methane, and oxygen indicated in the graph on the right. As these gases have risen and fallen, different kinds of organisms have proliferated.



Telescopic observations indicated that the atmosphere of Mars is largely composed of carbon dioxide and, according to Lovelock, remains close to "chemical equilibrium." The same, he says, was found to be true with the atmosphere of Venus. That is, if air were heated and then slowly cooled in the presence of rocks from either of these planets, its composition would change very little. "The gases in the Earth's atmosphere, on the other hand, are in a persistent state of disequilibrium," according to Lovelock. The same experiment with Earth's air would result in a loss of its predominant compounds, nitrogen and oxygen, and an increase in carbon dioxide.

"It was impossible to ignore the sense that the Earth was a strange and beautiful anomaly," Lovelock writes. Could "the fact that Earth alone bears life" explain it? Lovelock hypothesized that the planet's atmosphere works in concert with the oceans and lands to keep from changing to an equilibrium state. For him, the system that maintains life on Earth seemed comparable to the physiological system that coordinates circulation among the lungs, heart, and other organs of the human body. A new field—geophysiology—was needed to understand how the Earth functions, he concluded.

The idea sparked the interest of Margulis, who heard Lovelock talk at a meeting at Princeton University in the 1960s. She went on to explore the role microbes might play in controlling the atmosphere. Although Margulis would not go as far as Lovelock and say that the Earth is "alive," by the early 1970s the two scientists had developed a theory concerning a biological control system for Earth.

Lovelock called the system Gaia. Penelope Boston, who assisted with the recent AGU conference, thinks the poetic name for the theory "may have been a strategic mistake." But Lovelock's daring view might have gone unnoticed without such language. If you have a

big concept, you ought to have a name equal to it, advised the novelist William Golding, a friend and neighbor of Lovelock. And as Lovelock has joked, Gaia is "a more convenient term than biological cybernetic system with homeostatic tendencies."

No Nanny in Control

Early in Earth's 4.5 billion-year history, Lovelock believes, the land matter, atmosphere, and oceans were evolving according to the laws of physics and chemistry. Then at some point, he writes, the planet "entered a stage favorable for life." As life was created, it merged with "the rocks, the air, and the oceans . . . to form the new entity, Gaia. Just as when the sperm merges with the egg, [Gaia] was conceived."

A main argument underlying Gaia states that organisms have maintained Earth's climate at a relatively steady state for at least 3.6 billion years—in other words, as long as life is thought to have existed on the planet. A steady-state climate would seem paradoxical, since it is widely accepted that at the beginning of this period the sun was releasing 70 to 75 percent of the energy it is now. Some scientists have theorized that gases in Earth's early atmosphere produced a "greenhouse effect" to trap heat, but this does nothing to explain what has happened since, Lovelock says. He speculates that microscopic organisms in the early atmosphere produced methane, a greenhouse gas. What prevented the atmosphere from becoming intolerably warm is that the methane eventually decreased while the oxygen increased enough to allow new kinds of organisms—photosynthesizing plants—to predominate, according to Lovelock. Although the sun has steadily been emitting more energy since then, oceanic blue-green algae and phytoplankton may have compensated, playing key roles in removing the principal greenhouse gas, carbon dioxide, from the air.

Almost all the absorbed carbon remains buried in the form of calcium carbonate (limestone). Some limestone is on the floor of the sea, while much is on land now, having developed in the ocean years ago. In addition, organisms living on calcium silicate rocks have caused them to weather much faster. This has meant that more calcium has been carried to the sea, combined with still more carbon, and deposited as limestone, Lovelock says. He claims that over the long run, carbon dioxide absorption and the heating of the sun have been more or less in balance.

Another argument supporting the Gaia hypothesis is that, according to Lovelock, the amount of oxygen in the atmosphere has stayed at 21 percent for the last 200 million years. If it rose to 25 percent, he says, disastrous forest fires would occur whenever there was lightning. And less than 15 percent oxygen would make starting fires impossible. Photosynthesis, which releases oxygen, might appear to be one factor in the equation. According to Lovelock, however, that process has no significant effect, since the amount of oxygen it creates is almost entirely used by animals and certain microorganisms. He thinks that photosynthesizing plants make their real contribution after they die, when one one-thousandth of the carbon they have absorbed is buried in the form of coal or the like—and an equivalent percentage of oxygen is added to the atmosphere. Sulfur gases emitted from volcanoes and chemicals released by weathering rocks and magma emerging on the ocean's floor check the buildup of oxygen, combining with it to form compounds such as ferric iron—rust—and sulfate.

Although life forms don't have foresight, they adjust Earth's environment to ensure their continued well-being, Lovelock says.

If life forms control Earth's environment and so ensure their continued well-being, does that suggest that they have some kind of foresight and planning? Lovelock thinks not. To explain how life could be "at the controls without requiring some kind of giant nanny looking after the Earth," he has invented the concept of "Daisyworld."

"Picture a planet about the same size as the Earth, spinning on its axis and orbiting, at the same distance as the Earth, a star of the same mass and luminosity of the Sun," writes Lovelock in *Ages of Gaia*. On

the planet the only life forms are several kinds of daisies, ranging in color from light to dark. They receive moisture only from nighttime rainfall, as there are no clouds during the day.

In this parody of a global circulation model, the dark-colored daisies absorb the sun's heat and warm the planet. As it becomes too warm for them to survive, their seed production drops, and the white daisies have an opportunity to spread. Thus without foresight or planning life affects the environment and is affected by it at the same time.

Scientists' Reactions to Gaia

Most scientists don't have qualms about the basic concept behind Daisyworld—that feedback systems affect the environment. But by and large, they dispute the idea that life controls the environment and thus maintains its habitability. Instead, they think that life merely influences the world.

Some geochemists resist the hypothesis since it contradicts their explanations of Earth's atmospheric phenomena. Harvard University geochemist Heinrich Holland, a staunch opponent of the Gaia hypothesis, says, "There's very little scientific basis for the thing. Many of us are starting to feel we understand the geochemistry of the atmosphere and the oceans. We feel that Jim has gotten ahold of one piece, and that he is overemphasizing the biosphere vastly." Holland thinks Lovelock is ignoring the importance of the hydrologic cycle and volcanoes that spew out carbon dioxide and sulfur.

Atmospheric chemist James Kasting of Pennsylvania State University goes one step farther, arguing that Earth's temperature can remain stable and habitable for life even without biological influences. In the February 1988 issue of *Scientific American,* he and colleagues describe a process by which a geochemical feedback system could take carbon dioxide from the atmosphere and cool the planet's temperature. Kasting agrees with Lovelock that phytoplankton and blue-green algae remove carbon from the atmosphere and ocean and make calcium carbonate, but he counters that calcium ions in seawater also could combine with carbon inorganically to produce the same material.

Some scientists find aspects of the Gaia hypothesis useful in their research, however. Lee Kump, a geochemist at Pennsylvania State University, argues that geochemical models of atmospheric oxygen are missing some fundamental control processes. He refers to the widely cited "modified Blag model," which calculates changes in atmospheric oxygen through time. It indicates that oxygen levels should have fluctuated wildly in the past 600 million years. "This would have been impossible without dramatic consequences, such as the end of breathing organisms or disastrous forest fires," Kump says. "I'm convinced that the biosphere is playing a major role in the Earth's chemistry and climate, and I've been taken along this path by Lovelock."

Yet so far there's no proof of any specific biological feedback mechanism that can control environmental conditions. Even the most promising evidence has recently been contested. In 1971 Lovelock found a profusion of a chemical called dimethyl sulfide (DMS) in the the ocean. He subsequently calculated how much DMS is transferred to the atmosphere. In 1987, Lovelock, along with meteorologists Robert Charlson and Stephen Warren of the University of Washington and M.O. Andreae, director of the Max Planck Institute for Ocean Science in Mainz, Germany, published a paper in *Nature* explaining how several species of oceanic phytoplankton that produce DMS could help control climate. DMS would oxidize in the atmosphere, leaving droplets of sulfuric acid that could produce clouds. These clouds would reflect the sun's heat and cool the planet.

But no one has shown how the system could form a total feedback loop—how changes in climate could trigger different growth rates in the phytoplankton that are emitting DMS.

And in a December 1988 article also published in *Nature,* Stephen Schwartz, a chemist at Brookhaven National Laboratory, pointed out another possible problem. He noted that fossil-fuel plants are emitting sulfur dioxide—which is transformed into sulfuric acid—at rates comparable to those at which phytoplankton emits DMS. Therefore, he reasoned, the greater use of such fuels in the Northern Hemisphere should mean that it has more reflective clouds than the Southern Hemisphere, and that it is cooler. But when he investigated, he found no difference between the two hemispheres. Schwartz concluded that in today's atmosphere, cloud reflectivity and temperature do not respond to sulfur emissions—including DMS.

Finally, some scientists have disagreed with Lovelock's views on industrial pollution. In 1975, for example, he pooh-poohed the idea that chlorofluorocarbons (CFCs) were harming the ozone layer. But even his critics acknowledge that he has made major contributions toward an understanding of the global environment. "I don't

Even Lovelock's critics acknowledge that he has made major contributions toward an understanding of the environment.

think there's a single scientist working in tropospheric science who hasn't been influenced by him," says Michael Oppenheimer, an atmospheric chemist with the Environmental Defense Fund. "Ironically enough, though, as a scientist he has been wrong on specific notions, like the threat of CFCs to the ozone layer."

In recent years Lovelock has conceded that the amount of CFCs now emitted poses a threat. But he still argues that their effect of thinning the ozone layer and thus increasing ultraviolet radiation is not as dangerous as many claim. "It's a middle-class, white-skinned person's problem," Lovelock says.

He believes that deforestation is a far greater hazard because it is a key contributor to global warming. Trees give off carbon dioxide when they are cut down and decay. And when there are fewer living trees, less carbon dioxide is absorbed from the atmosphere. Indeed, because of Lovelock's concern about deforestation, some scientists find themselves agreeing with his ideas.

"Gaia theory sees the Earth as a responsive living organism that will at first tend to resist environmental change and maintain homeostasis," he comments. "But if stressed beyond the limits of whatever happens to be the current regulatory apparatus, it will jump to a new stable environment where many of the current range of species will be eliminated." In other words, humanity could die out, while a variety of other forms of life, such as bacteria and microbes, would survive.

Some scientists who have started listening to Lovelock think Gaia is less important as a concrete theory than as a new paradigm. "I see it not as a completely worked-out hypothesis but as a generator of new hypotheses," says Tyler Volk, an oceanographer at New York University.

Moreover, the Gaia idea is encouraging interdisplinary study. In this respect it has had a major effect on one of the most ambitious international science programs, according to Walter Rosen at the National Academy of Sciences. In 1986 the International Council of Scientific Unions launched the decade-long International Geosphere-Biosphere Program (IGBP) to find out more about global climate change. "It's really pretty revolutionary. You have oceanographers talking to biologists, atmospheric chemists talking to microbiologists, [scientists] crossing all sorts of interdisciplinary boundaries," Rosen says.

"I am convinced that Gaia influenced [IGBP] by putting that little switch in everyone's brain that leads to questions of the type 'What is the global biosphere's role?' " notes Volk.

Since the AGU conference, a number of scientists have started looking at how the biosphere may affect the environment. David Schwartzman, a geologist at Howard University, is studying the role of soil microbes in accelerating the absorption of atmospheric carbon dioxide through weathering. Gaian concepts have stimulated much of the work that Ralph Cicerone of the National Center for Atmospheric Research conducts on trace gases, particularly methane. And Lee Kump is examining how forest fires may regulate atmospheric oxygen levels.

Moreover, at least half a dozen courses on the Gaia theory are being taught at universities around the country. Even some detractors such as James Kasting of Penn State are offering classes on the topic, because it makes students think about how Earth might work.

It's still too early to say what will happen to the Gaia hypothesis. Lovelock's collaborator, Lynn Margulis, thinks that feedback mechanisms will be discovered to prove the idea, although the work may take years. In the meantime, she points out that no one has yet uncovered mechanisms to prove Darwinian evolution either.

And scientists like Lee Kump don't mind that the Gaia hypothesis isn't producing immediate breakthroughs. "Many of the big revolutions in science have been spawned by what were considered at the time to be crazy ideas—continental drift, for example. Lovelock is making us take another look at how the Earth works." ■

Controlling Risk in Biotech

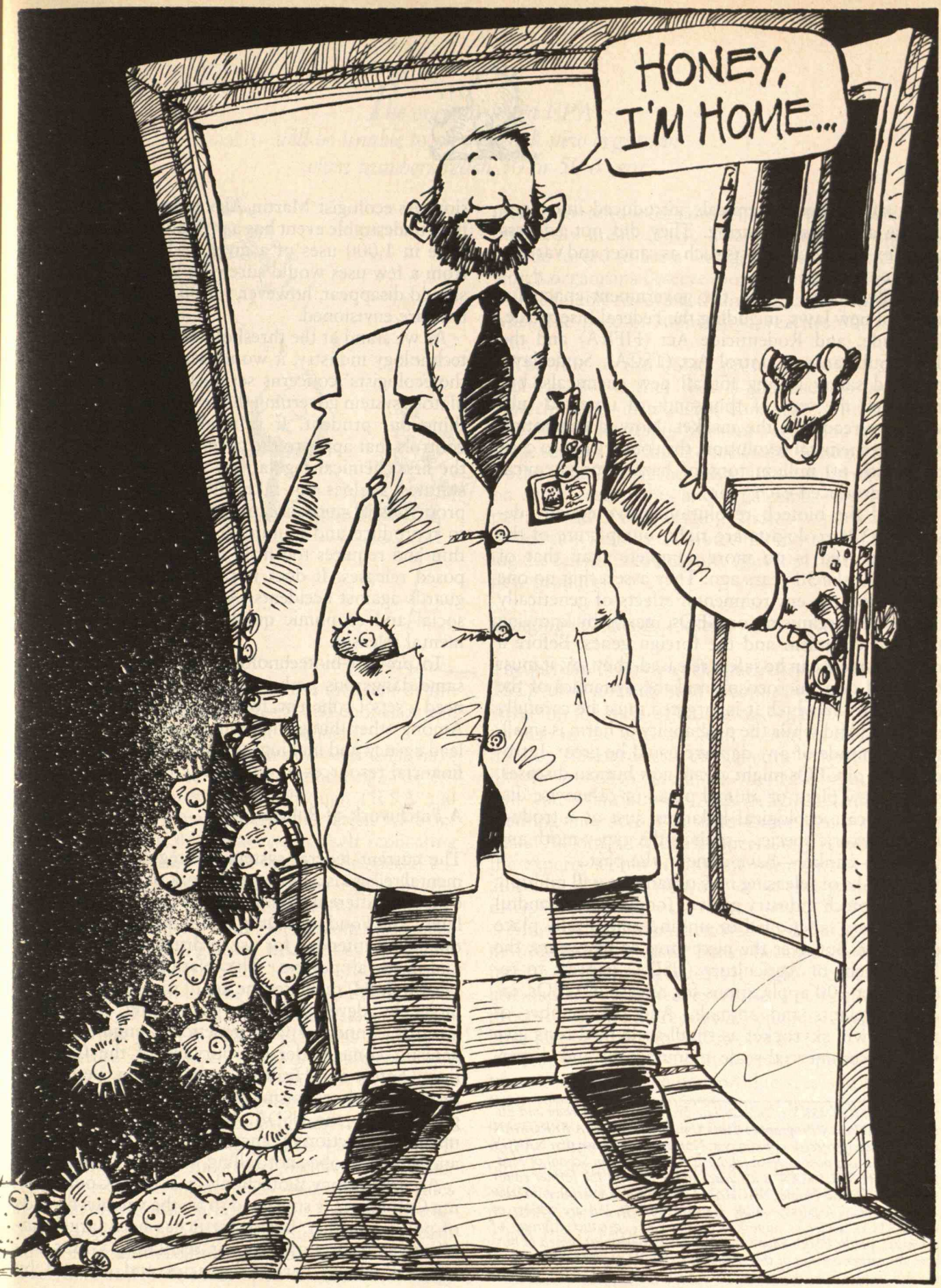
As more and more engineered organisms move from the lab to the environment, we cannot afford to be complacent about the risk. Better regulations are essential.

BIOTECHNOLOGY entrepreneurs envision a future where genetically altered bacteria digest oil spills and toxic waste, kill crop pests, and immunize wild animals against rabies. These organisms, say the biotechnologists, pose no unique hazards to health or the environment; they are as safe as their component parts—a natural bacterium and a gene taken from another organism.

This optimism brings to mind the early days of the synthetic-chemical industry. Like biotechnologists, chemical pioneers of the 1940s and 1950s saw great promise in new products that would be released into the environment. But government regulation of these chemicals was based on public health statutes that dated from the turn of the century. These statutes were not suited to deal with the thou-

BY
SHELDON KRIMSKY, KOSTIA BERGMAN, NANCY CONNELL, SETH SHULMAN, AND NACHAMA WILKER



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sands of synthetic chemicals introduced into agriculture and manufacturing. They did not address complex biological effects such as cancer and various chronic illnesses.

Finally, in the 1970s, the government enacted a series of new laws, including the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA). Some laws required safety testing for all new chemicals, but exempted the tens of thousands of untested substances already on the market. Now, a generation after the chemical revolution, the country has to contend with 60 million tons of hazardous chemical wastes produced each year.

Could the biotech revolution prove equally destructive? If ecologists are right, our picture of the risks involved is no more complete than that of chemical risks 30 years ago. They assert that no one can predict the environmental effects of genetically engineered organisms, or GEOs, merely by knowing the host organism and the foreign genes. Before a new organism can be safely released, they say, it must be tested in a microcosm, and the dynamics of the ecosystem for which it is targeted must be carefully modeled. And while the probability of harm is small, the magnitude of any damage could be great. Introductions of GEOs might create new human diseases, spawn new plant or animal pests, or otherwise disrupt delicate ecological balances, just as introductions of exotic species—such as the gypsy moth and the citrus canker—have done in the past.

The risks of releasing new organisms will multiply as the biotech industry grows. Today only a handful of releases, sanctioned or unsanctioned, take place each year. But over the next three to five years, the Department of Agriculture (USDA) expects to receive over 200 applications for release of GEOs, including plants and animals. And the number of releases will skyrocket as small-scale field tests give way to commercial-scale manufacture and dispersion. As ecologist Martin Alexander has cautioned, if an undesirable event has a probability of occurring once in 1,000 uses of a given technology, the risk from a few uses would surely be low. Complacency should disappear, however, if 600 or 1,000 or more uses are envisioned.

As we stand at the threshold of a burgeoning biotechnology industry, it would seem prudent to take the ecologists' concerns seriously. Yet the U.S. regulatory system governing the release of GEOs is anything *but* prudent. It is modeled after the same controls that apply to the chemical industry—just as the first chemical regulations were based on earlier statutes. It does not take into account the unique properties of microorganisms, such as their ability to reproduce and mutate. It spreads oversight too thin and requires too little scientific review of proposed releases. It does not provide adequate safeguards against accidents. And it ignores important social and economic questions raised by environmental releases.

To prevent biotechnology from going down the same dangerous path as the chemical industry, we need a set of coherent, forward-looking regulations. Among other things, that will mean creating a single lead agency and making sure it has the technical and financial resources to do its job.

A Patchwork of Policies

The current federal system for regulating environmental release is a loose patchwork of policies spread over five different agencies and at least ten different laws. The Food and Drug Administration regulates organisms intended for use in drugs, food additives, and medical devices. The National Institutes of Health (NIH) regulates the use of recombinant-DNA molecules developed with its funding. Workplace hazards connected with genetically engineered organisms come under the purview of the Occupational Safety and Health Administration. Veterinary products and organisms that could harm plants are governed by the USDA. Meanwhile, the Environmental Protection Agency (EPA) covers pesticides and new microbes not falling into other categories.

An interagency Biotechnology Science Coordinating Committee is supposed to tie the various threads of policy together, but so far it has been largely ineffective. With authority for regulating GEOs distributed among various agencies and covered by

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The overburdened EPA will be unable to review each new organism when numbers reach 30 or 50 a year.

widely disparate laws, agencies use different definitions and risk assessment criteria, and confusion can arise over who regulates what product.

All the statutes under which new organisms have been lumped predate genetic engineering. For example, EPA regulates releases through FIFRA and TSCA. Both laws, particularly the latter, were intended for chemical substances, not self-replicating organisms. The laws neither address the special environmental and public health risks raised by the new industrial and agricultural uses for GEOs nor establish a program for better identifying those risks.

Some of the most glaring weaknesses of current regulation stem from TSCA. Unlike FIFRA, which requires that a firm obtain a license to manufacture a substance, TSCA is a notification statute. All a company has to do is inform EPA that it plans to manufacture a certain chemical or biological. Since the manufacturer does not even have to provide data attesting to the safety of its products, a notification system places the burden of proof on the regulator.

EPA has 90 days to review a TSCA submission. If it determines that a substance might pose an unacceptable risk, the agency may issue a set of rules applying only to that product. This rulemaking process is cumbersome and laborious, and it injects considerable discretion into regulatory decisions.

As more and more companies notify EPA that they intend to release organisms, the system will undoubtedly break down. The overburdened agency will be forced to use a "triage" system to determine which organisms deserve more careful scrutiny, and will be unable to review them on a case-by-case basis when the pace of submissions reaches 30 or 50 a year.

The role of the USDA presents another serious problem. No agency that is supposed to promote biotechnology in industry, commerce, and agriculture should be responsible for regulating its use in those sectors. Yet this is exactly the position that the USDA is in. The agency also lacks a coherent policy on engineered plants and organisms. And it has a poor record of encouraging citizens to participate in its decision making on biotechnology and of informing the scientific community how it plans to evaluate new products.

Bringing in Outside Experts

The jerrybuilt framework that relies on FIFRA and TSCA does not take into account the complexity of weighing the risks of biological organisms designed for use in the environment. Scientists have yet to develop standard tests for genetically novel strains, like those used to determine whether a new chemical will cause mutations. And designing and implementing microcosm or field experiments can take years. As long as scientific uncertainty remains high, the experts within environmental agencies must be aided by a broad network of scientists in related disciplines.

Many scientists participated in debates over the first few GEO releases, either because of media attention or because a regulatory agency or a court of law had solicited their expertise. But as the review process becomes more routine, outside scientists will have less incentive to get involved.

Because scientists do not benefit professionally from troubleshooting new products, it is in the public interest for the government to provide financial incentives to attract outside reviewers. Unfortunately, while annual investment in U.S. biotechnology innovation from private, state, and federal sources totals nearly $5 billion, investment in expanding our knowledge of how these innovations affect the environment and public health is barely one thousandth of that figure.

In the future, the science of predictive ecology may

advance far enough to make standard tests for GEOs possible. At that point, the need for broad review may diminish. For now, however, the more diverse the thinking about possible harm, the better our chances of identifying and avoiding it.

Unsanctioned Releases

Even if the regulatory system were to do an adequate job of determining the safety of GEOs, its efforts would be meaningless without some guarantee that only safe organisms would reach the environment. Unsanctioned releases have already taken place in Montana, Nebraska, South Dakota, Texas, and California.

In addition, whole classes of release experiments are regulated inadequately or not at all. These include experiments in the private sector, university research, and large-scale fermentation. Some of these settings are inherently unsafe. In August 1987, for example, a biochemist working in his beachfront home in Kingston, Mass., was recombining the genes of sea organisms to create a new type of building material, when his house collapsed. Microorganisms, which the scientist maintained were not dangerous, escaped from his home. The investigator violated no law; private funds were involved, so he was not obligated to follow any guidelines. Since a harmful microbe can multiply and spread regardless of the type or size of organization conducting the test—or the source of funding—exemptions from the regulatory process make little sense.

It is not only in unregulated settings that accidents can occur. As the production of genetically altered organisms increases, so does the likelihood of unintentional releases. These can happen at any stage in an organism's lifecycle—from the laboratory to the production/fermentation facility, greenhouse, field test, and waste stream. Because many GEOs are designed to survive inside humans, laboratory workers can unwittingly serve as pathways for releasing the organisms and can themselves face potential health risks.

As for the possibility of a modified organism finding an environmental niche after "escaping" during a field test, again, the chances are slim—but any regulatory structure must be designed to handle a vastly greater quantity and diversity of such tests in the near future. When asked about the dangers of field tests, David Baltimore, head of the Whitehead Institute for Biomedical Research, has replied, "Would corn planted at the edge of the forest take over the forest?" Yet occasionally, introduced natural organisms do just that, causing widespread damage. Kudzu, for example, was imported to the Southwest for forage and erosion control, but has since become a major weed problem in forests and roadways.

If an organism did escape, the current regulatory regime would be unprepared to deal with the ecological upset that might ensue. No plans have been developed for containing damage. Nor are any serious research programs under way in this area.

While the regulation of GEOs during research and testing is merely inadequate, the regulatory framework for dealing with biogenetic waste is virtually nonexistent. The biotechnology industry brings with it a new form of waste that can live and multiply in the environment. Because it consists of living organisms, biological waste has the potential to spread disease. It could also transfer genetic material to organisms of different species, genera, and even families, fostering the creation of new pathogenic strains or compromising the ability of humans, animals, or ecosystems to protect themselves. The rapid spread of antibiotic resistance among bacteria in clinical settings is an obvious example of the ease with which certain kinds of genetic exchange take place.

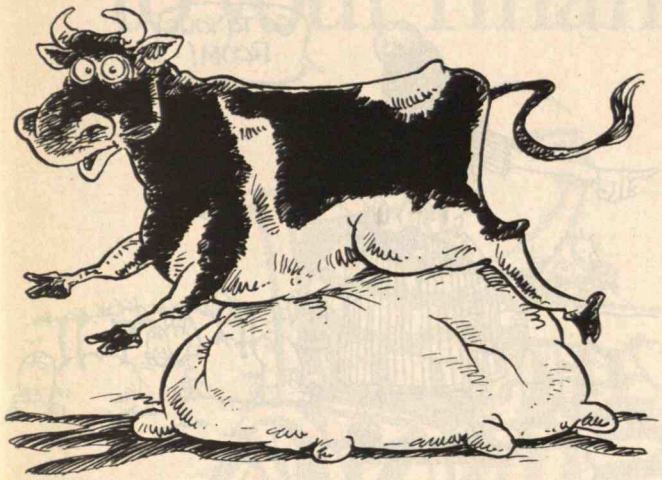
However, the only regulations for treating biogenetic waste are NIH guidelines, which have no legal authority over industry, and FDA rules for sterilizing bioreactors. Most industrial fermentation plants may simply dispose of spent GEOs along with other untreated effluent.

A Socioeconomic Vacuum

Just as important as an organism's environmental impact are its social and economic consequences. During the Reagan era, the administration directed regulators to consider the adverse economic effects that new regulations might have on business. Yet the government has always been reluctant to take this one step farther and consider the economic effects of actions proposed by industry. A product that will create inequities within the industrial community or that threatens social transformation leaves the regulators silent for lack of authority.

The assessment of biotechnology needs to be expanded beyond the narrow criteria adopted by the

Bovine growth hormone from engineered organisms can boost milk production 30 percent, but regulations do not take record surpluses into account.



Reagan administration. An independent body should analyze the social, ecological, and economic impacts on all sectors, including small farmers, consumers, and the natural environment.

"Ice minus," the controversial organism developed by Advanced Genetic Systems in Oakland, Calif., sparked opposition from farmers in Tulelake, Calif., where it was slated for field testing. In addition to their concerns about possible environmental harm, the Tulelake farmers believed that the organism, designed to replace natural bacteria that raise the temperature at which frost forms on plants, might increase the land devoted to potato farming. The result, they feared, would be increased competition in what was already a low-profit-margin enterprise. Yet farmers' economic interests were largely ignored in the debate over safety, even though they could easily have been included and weighed against the new product's purported benefits.

Or consider the case of bovine growth hormone, which can now be produced using genetically engineered organisms. When injected into cattle, the hormone can increase milk production by up to 30 percent. But what economic impact will the hormone have at a time when milk surpluses are at record highs? The regulatory framework does not take such socioeconomic effects into account.

When an industry designs a new product for release into an environment where it will pose discernible risks, we must ask: What do we gain? What could we lose? What are we displacing? Does the new product fill real social needs? We cannot rely on industry to answer these questions for us. Advanced Genetic Sciences, for example, promoted ice minus as a substitute for chemical pesticides, even though pesticides have never been the method of choice for preventing frost damage. Meanwhile, other agrochemical and biotechnology companies are genetically engineering crops resistant to harmful side effects of pesticides—a practice that will expand and prolong the chemicals' use. Pesticides are the most profitable products of some of these corporations. Yet biotechnology could also be used to develop non-pesticide alternatives that would lessen farmers' dependence on a few big agrichemical companies.

With a powerful emerging technology, especially one with potential risks and large amounts of public funding, we cannot assume that the market will operate in the interest of the public without social guidance. The public sector should actively shape public policy, not allow it to be created by default. If weaning agriculture from chemical pesticides is a desirable goal, then public policies should help realize it.

In deciding what degree of risk is acceptable, regulators must begin to weigh the interests of industry against those of society at large. If the overall social and economic effects of a product are negative, any environmental risk that accompanies its testing or use should be deemed unacceptable. At present, no regulatory mechanisms exist for making such judgments or for answering communities' questions about social and economic impacts.

Toward a Sound Regulatory Process

The present ambiguous and conflicting state of regulation satisfies no one. It creates confusion in the biotechnology industry, it does not adequately safeguard public health and the environment, and it largely excludes the public from the decision making. To deal with the coming wave of genetically engineered organisms, the system needs a top-to-bottom overhaul. The following proposals would help create a rational regulatory process:

Make EPA the lead agency. Designating one agency to oversee all environmental releases of genetically engineered organisms would help ensure careful review of the risks before a release was authorized. EPA should also be given greater authority over all large-scale uses of GEOs and empowered to regulate and inspect facilities to reduce the danger of accidental releases.

Amend TSCA. As applied to new organisms, the

Penalties for unauthorized releases of organisms should be high enough to discourage even small violations.

Toxic Substances Control Act is clearly inadequate. Instead of merely notifying EPA of a planned release, companies should be required to obtain licenses. As a prerequisite, the manufacturers—not EPA—should have to demonstrate an organism's safety and efficacy, as well as show that they are prepared to stem the worst impacts of a release. When a new technology is replacing an established one, the law should require end users to choose the least risky available technology to do a job. EPA should also have the latitude to request further information and testing on comparative risks.

Regulators also need to be able to penalize wrongdoers quickly and effectively—and the penalties should be high enough to discourage even small unauthorized releases. EPA should have the power to assess fines for violations without taking companies to court. This would shift the burden of bringing suit onto violators.

Give regulators more resources. The expansion of industry's genetic experimentation will place tremendous economic pressure on regulators to act quickly and without due care. With more funding, regulators would be able to provide better oversight within a timeframe that industry could live with. They would also be able to hire the necessary range of professionals—including soil ecologists and microbiologists—and keep them up to date on the latest developments in the field and techniques for evaluating them. Funding will need to grow with the industry, and could come in part from a tax on marketed products.

Set up advisory boards. Outside advisory boards could bring a fresh perspective to difficult technical, social, and economic problems in issuing permits. To prevent conflicts of interest, appointees to such boards would have to disclose any affiliations with, or equity interest in, biotech firms.

Encourage independent review. Funding must be available to bring the expertise of independent ecologists to bear on assessing the risks of new products. Publishing the name of an organism in the *Federal Register* and expecting scientists to divert themselves from busy schedules to examine the ecological consequences of a large-scale release is unrealistic. The government should contract out the review of new products to scientists in different disciplines, and the details of proposed field tests should be published in a variety of professional journals.

Involve the public. A public voice in the regulatory

process is vital, since the experts' assessment of "acceptable" risks may differ dramatically from the views of the public that bears those risks. Such involvement can also benefit industry. For one thing, communities may be able to contribute useful information in the deliberations. For another, communities left out of the process are likely to oppose, and even obstruct, local releases.

Good precedents for involving local residents exist under other laws. The 1986 Superfund Amendments, for example, established the community's right to know the type and amount of toxic chemicals released into the environment by industry. This right could be extended to the storage and release of genetically engineered organisms. Communities should be informed about the potential risks of any release, as well as plans for monitoring the organism and stemming any damage it might cause.

Of course, the right to know should not infringe on manufacturers' legitimate trade secrets. But to prevent spurious claims, the burden of proof for trade secrecy must be on industry.

Public involvement need not be merely reactive. In Cambridge, Mass., for example, a citizens' review board played a constructive role in developing the city's regulations for recombinant-DNA experiments during the 1970s. Any EPA advisory boards should include representatives from public-interest and community groups.

Strengthen risk assessment. For every proposed release, the manufacturer should prepare an environmental impact statement before EPA issues a permit. Such studies should analyze worst-case scenar-

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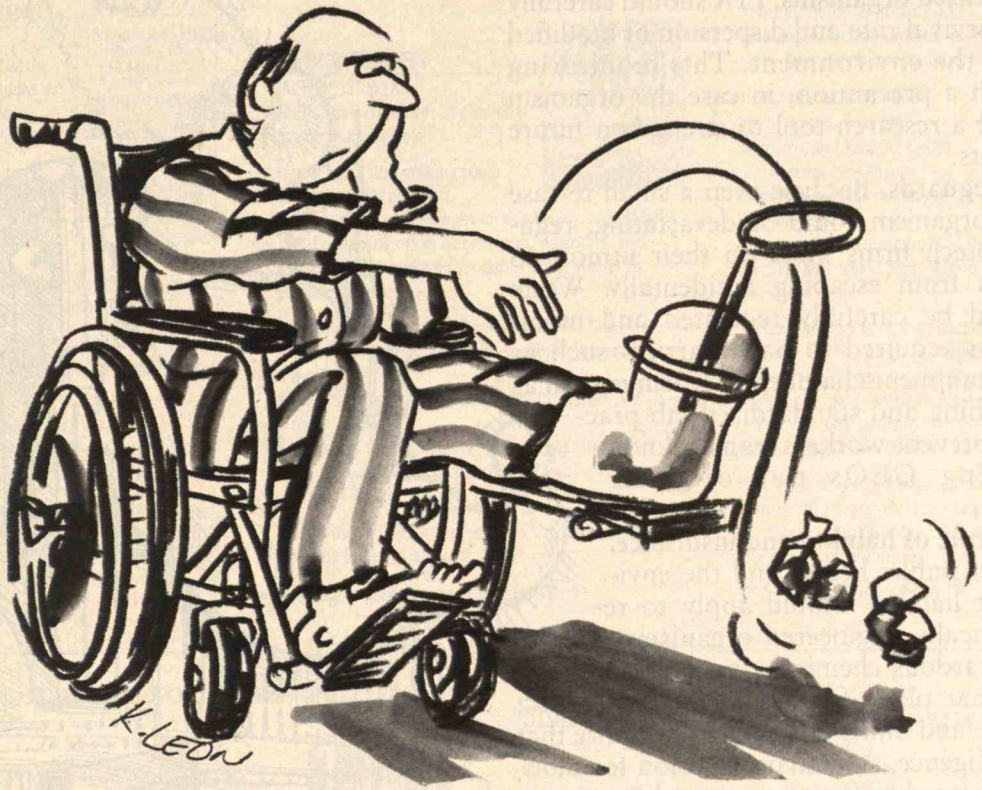

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For every proposed release, the manufacturer should analyze worst-case scenarios.

ios and specify the assumptions used in developing them.

Monitor released organisms. EPA should carefully monitor the survival rate and dispersion of modified organisms in the environment. This monitoring would be both a precaution, in case the organism did harm, and a research tool to strengthen future risk assessments.

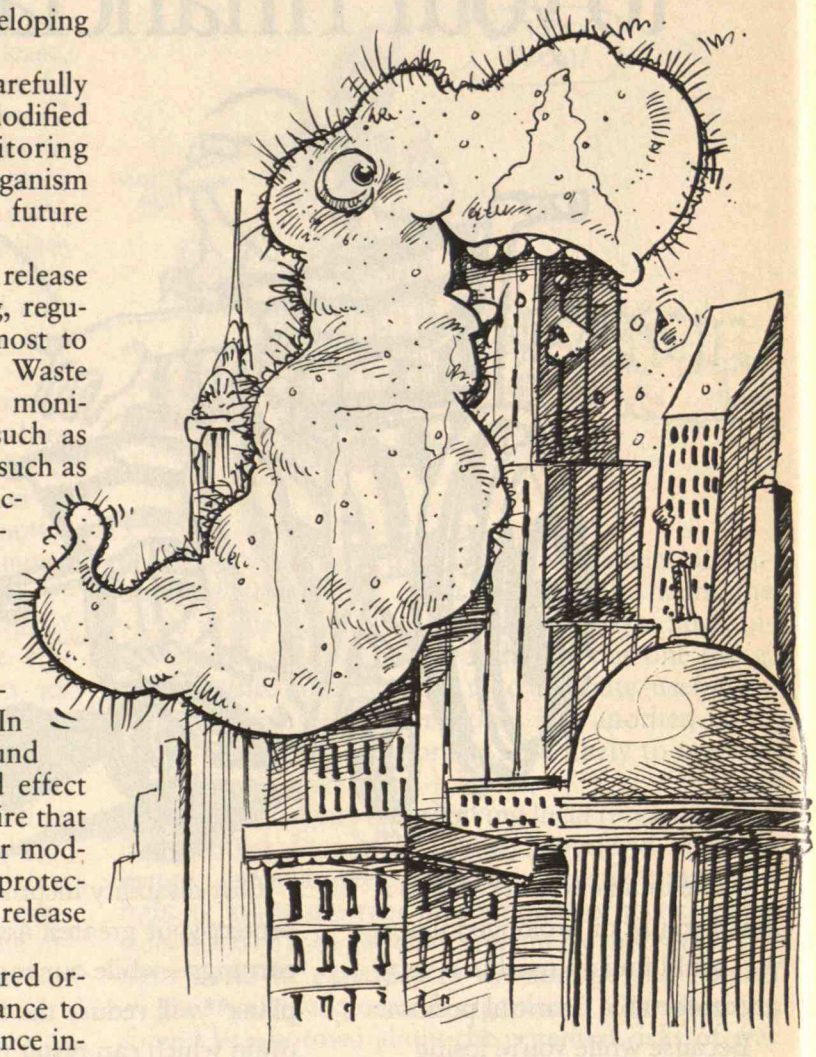
Increase safeguards. Because even a small release of a harmful organism could be devastating, regulators and biotech firms must do their utmost to prevent GEOs from escaping accidentally. Waste streams should be carefully regulated and monitored, and labs required to have barriers such as secondary containment chambers. Measures such as protective clothing and standardized lab practices can help prevent workers from unknowingly carrying GEOs out of their laboratories.

Expand the role of liability and insurance. To help protect public health and the environment, strict liability should apply to releases of genetically engineered organisms. In the case of hazardous chemicals, the Superfund law requires that plaintiffs show cause and effect between release and injury but does not require that they prove negligence. A similar provision for modified organisms would offer stronger public protection and force manufacturers to consider any release more carefully.

Companies that release genetically engineered organisms should have to carry enough insurance to cover any claims. This would give the insurance industry an incentive to help develop techniques for evaluating the risk of releasing new organisms.

Pursue international coordination. Environmental safety is a global, not a domestic, concern, since an accidental release of GEOs could harm food crops or human health worldwide. Whether through international scientific meetings and exchanges or through more formal international channels, issues concerning environmental releases must be addressed globally.

For example, the United States should prohibit multinational corporations based in this country from conducting field tests or other procedures abroad that have been prohibited at home. And scientific data about environmental safety must be widely shared to deter nations (especially in the Third World) from allowing ill-tested procedures



within their borders for the sake of short-term economic gain.

If we fail to move on these fronts, or if we move too slowly, there is every danger that the painful history of the synthetic-chemical industry will repeat itself in the realm of biotechnology. The public became aware of chemical hazards—and the government responded to them—only after substantial damage to health and the environment had occurred. Regulators tried frantically to catch up after decades of neglect. But the nation's economy was already dependent on the firmly established industry.

It is too late to undo all the damage done by synthetic chemicals. But if we can introduce some foresight into the regulatory system, it is not too late to avert disasters from genetic engineering. ■

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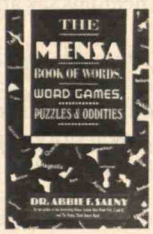

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Reviews

THE MEDIA

Science by Press Conference

BY FRED JEROME

Coming in the same week as Three Mile Island's tenth anniversary and the largest oil spill in U.S. history, the March 23 "cold fusion" press conference in Salt Lake City couldn't have been more timely. Whether the experiment by University of Utah chemist B. Stanley Pons and his British colleague Martin Fleischmann indeed produced fusion and, if so, whether it will actually lead to a new source of cheap, limitless energy remains to be seen. But the frenzy of publicity surrounding the experiment says as much about the scientific community's increasing obsession with competition and cash—and, therefore, headlines—as it does about the possibility of cold fusion.

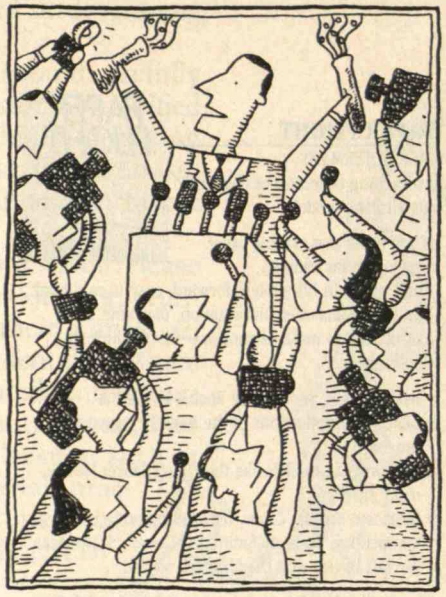
Call it "science by press conference." Competition for funding and other financial pressures push universities to "get ink." A growing army of science publicists promises to provide it. The combination threatens to turn science coverage into a sales convention. Fortunately for the public and for the long-term prestige of the scientific enterprise, this time journalists weren't buying what the Salt Lake salespeople were selling.

Fusion Confusion

The March 23 press conference and the many briefings that followed at other universities were organized, managed, and often scripted by politicians, university officials, or public-information officers who "presented" the scientists to the news media. Without absolving the scientists of their responsibility, it was often press statements from these officials—rather than the comments of scientists themselves—that contained the most dramatic and "newsworthy" breakthrough claims.

University of Utah officials distributed a press release declaring that Pons and Fleischmann had "created a sustained nuclear fusion reaction at room temperature." Yet Pons later conceded, "We don't know that it's fusion" and admitted that his and Fleischmann's results might have been caused by something else.

At an April 10 press briefing, it was announced that researchers at Texas A&M had



replicated part of the Pons and Fleischmann experiment. University spokesperson Edward Walraven told reporters that the scientists involved "believe there is no other explanation [for their results] than that fusion is taking place." Yet when asked about this, Texas A&M chemistry professor Charles Martin said, "You haven't heard us say anything about fusion."

Whatever happened to the publicity-shy scientist who criticizes the media for "sensationalist" reporting of unsubstantiated and incomplete stories? In the fusion story, such sensible restraint disappeared in the rush to be first off the mark.

The March 23 press conference in Salt Lake City was convened on just two days notice. No advance press releases were sent out; journalists were invited by telephone. The result was serious misstatements and sloppy science. For instance, both Pons and Fleischmann and University of Utah vice-president for research James Brophy have claimed that a paper about the cold fusion experiment had been accepted by the *Journal of Electroanalytical Chemistry and Interfacial Electrochemistry* before the press conference. But a spokesperson for Hill and Knowlton, the PR firm representing the journal's publisher, told me that the paper was not accepted until March 30, a full week after the briefing. And once the paper was made public, researchers found that it contained no clear information on some basic control experiments that would have helped determine whether the reaction that Pons and Fleischmann reported was really fusion.

Dealing in Fusion Futures

Utah's Brophy maintains that the decision to go public came in response to rumors of forthcoming news reports that were "full of inaccuracies." But the university's rush to coverage probably had more to do with competition and cash than with worries about press leaks.

The competition came primarily from a research team headed by physicist Steven Jones, a fusion expert at nearby Brigham Young University. As a reviewer of grant proposals for the Department of Energy, Jones had early access to details of the Pons-Fleischmann project. University of Utah officials imply that Jones stole from the Pons-Fleischmann proposal to revise his own fusion studies, a charge that Jones has denied. In fact, Brigham Young officials have countercharged that the two universities had an agreement to cooperate on fusion research, an agreement that the University of Utah broke by going public on March 23.

A likely factor driving this competition was the hope of university officials for a big financial payoff. On April 7, Utah governor Norman Bangerter called a special session of the state legislature, which allocated $5 million for further fusion study at the state university—on the condition that the initial research claims held up. "We don't want this to get out of Utah," a spokeswoman for the governor told the *Wall Street Journal*. Maybe she was recalling how the artificial heart—another supposed breakthrough pumped up by the University of Utah's public-relations staff—had been lured away from the state by the Humana Corp.

Even if the Pons-Fleischmann breakthrough breaks down, the University of Utah may still turn a buck. Brophy told me in early April that the university was rushing to formulate its own licensing program. Companies, he explained, will be able to buy an "option" to license the fusion process at some future date. According to Brophy, some 200 companies, including "several in the Fortune 500," had already contacted the school—even though the Pons-Fleischmann process is far from being proved. Selling such options is "standard practice," Brophy assured me.

On the Bright Side

There are no easy solutions to the problems posed by press-conference science. Most proposals either are ineffective or contain problems of their own.

One possible solution would be to

ILLUSTRATIONS: JAMES KACZMAN

strengthen the hand of journal publishers. For example, the *New England Journal of Medicine* bars its contributors from any comment to the press before publication. But many science reporters, this writer included, feel this gives a handful of journal editors too much power over what the public hears.

It might help if public-information directors at universities and research institutes thoroughly checked out claims instead of playing the salesperson's role. But if the top people at an institution want to promote an unsubstantiated breakthrough, chances are a press conference is going to get called no matter how good the public-information staff is. At Utah, university news director Pam Fogle reportedly recommended against holding a fusion press conference until the results of the Pons-Fleischmann experiment were published in a professional journal. She was overruled.

If scientists themselves exercised more self-restraint and insisted that their institutions keep quiet until findings have been reviewed by peers and then published, the trend toward science by press conference might slow down. Pons and Fleischmann have been widely criticized by other scientists for short-cutting the publish-before-publicize approach. If their claims of having produced cold fusion prove false, this could spark an even broader backlash within the scientific community against colleagues who cut corners. Still, all the pressures that push scientists to go public early will remain.

Government and corporate sources of research funds already impose all kinds of restrictions on information. Given a choice between more limits and more announcements of untested and unconfirmed research results at press conferences, I would choose openness every time. Perhaps the bright side of the fusion story is that journalists managed to describe quite accurately the uncertainty in the scientific community—uncertainty that is, after all, crucial to the scientific process. Coverage of cold fusion has generally been thorough and balanced, reflecting the scientific community's skepticism as well as hope about the Utah claims. At the same time, all the controversy stimulated lively science reporting and unusually wide public awareness of a topic most folks had never heard of. In the end, the best defense against science by press conference may be the science media. ■

FRED JEROME is executive vice-president of the Scientists' Institute for Public Information.

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by Mark Sagoff
Cambridge University Press, $29.95

BY DANIEL GROSSMAN

Soon after his inauguration as president in 1981, Ronald Reagan signed Executive Order 12291, requiring that all major government regulations pass a "cost-benefit" test. The directive was the culmination of a historic trend toward making economic efficiency the sole standard of public policy. Previous administrations had required that the costs of regulations be compared with the benefits, but not until Reagan's order were new regulations actually prohibited that did not "maximize the net benefits to society" in a quantifiable way.

The Economy of the Earth by Mark Sagoff is a philosophical counterattack on this point of view. Sagoff, a scholar at the University of Maryland's Center for Philosophy and Public Policy, explains why cost-benefit analysis is likely to lead to unacceptable social policy, and offers what he believes is a better approach. Although Sagoff's alternative is not as compelling as his critique, this book succeeds in demonstrating how the spread of economic thinking to many areas of social life puts democratic politics at risk.

Shadow Prices and Rights to Pollute

Reagan's executive order was founded on the popular assumption among economists that the most efficient way to allocate resources is through private markets. But what happens when markets break down or, as in the case of public goods, do not exist in the first place? The classic example is air pollution. Corporations foul the air with noxious pollutants because, according to the logic of the market, the atmosphere is a free "dump."

In such cases, most economists agree that some kind of regulation is necessary, but they favor mechanisms like cost-benefit analysis that simulate those of the market as closely as possible. The usual approach is to determine the monetary value of clean air to the various individuals and institutions who use it—the public who breathes it, industries

The market may be appropriate for allocating consumer goods but not for regulating pollution.

who pollute it, etc.—and arrange for the most efficient allocation of this resource among them. This might take the form of determining a general effluent standard that balances the needs of various users. A more extreme approach might involve actually creating a market of rights to pollute—whereby permits to emit a specified amount of pollutants are freely bought and sold.

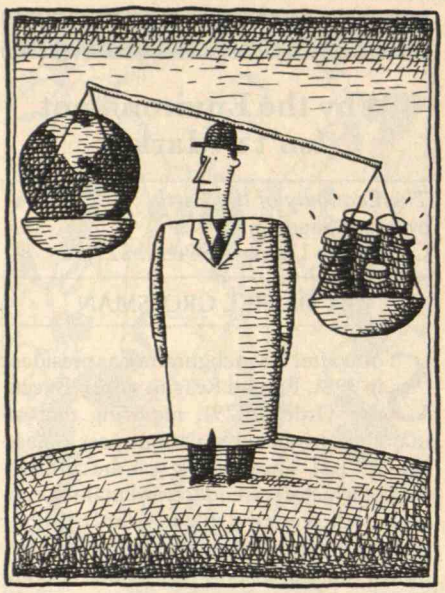
Of course, determining the "true value" of goods such as clean air presents a thorny methodological problem. One approach is to calculate hypothetical values, or "shadow prices," by means of survey questionnaires. Respondents are asked how much they would be willing to pay to obtain certain goods or how much they would have to be offered to agree to sell them. The worth of any given social good is considered the sum of this value for all individuals and institutions.

The Environmental Protection Agency (EPA) has used this technique to evaluate an air quality standard proposed for sulfur dioxide. University researchers, under contract to EPA's Air Quality division, showed a random sample of subjects some photographs depicting different degrees of scenic visibility. Interviewers asked the subjects how much more in electric rates they would be willing to pay to retain the various vistas. The resulting monetary values were added to figures representing the other advantages of clean air in order to calculate the overall benefits of the proposed standard.

Sagoff rejects the fundamental premise of such an exercise. The market, he argues, may be an appropriate mechanism for allocating consumer goods. But it is an inappropriate and potentially dangerous way to resolve pressing public policy questions, such as whether a park should be used for drilling oil or a company should be allowed to emit arsenic. Such questions are political issues and must be evaluated on their public merits rather than by merely adding up private preferences.

The Market vs. Politics

Sagoff's criticism of cost-benefit analysis is based on a fundamental distinction in democratic political theory between the private marketplace and the public sphere of politics. According to Sagoff, individuals play many roles in their daily lives, each demanding distinct ways of thinking and acting. In the realm of the market, we act as consumers, concerned with our personal wants and those of our families. Such preferences may be important to us as individuals but ultimately they are arbitrary. The make of car we buy or the brand of soap we use often does not admit rational justification.



In the realm of politics, on the other hand, we are not consumers but citizens, concerned with the good of the community rather than with our own interests. In political life, says Sagoff, we have not so much preferences as "values"—convictions that grow out of our experiences in society. Such values are rational in the sense that they are always open to deliberation and change—a process of dialogue marked by moral virtues such as respect for opposing opinions and the reliance on persuasion rather than force.

Consider the example of a trial by jury. No matter how harsh the disagreements among jurors, all are committed to a process of debate and persuasion. A trial is a public forum in which arguments are made and evaluated on their merits.

When economists try to determine shadow prices, argues Sagoff, they mistake citizens for consumers. They ask what people would pay when they should ask what people think. It is a little like a judge trying a case by asking each juror how much he or she is willing to pay to support a given verdict—even before hearing the evidence!

Cost-benefit analysis promotes the illusion of rationality by providing an abstract methodology that produces an automatic outcome. But like a trial by jury, a truly rational solution to policy problems requires "the ordinary virtues of inquiry and deliberation."

This may sound like an abstract philosophical distinction, but Sagoff persuasively argues that ordinary people understand it. He describes one researcher's effort to calculate the social value of clear skies, in which more than half the people interviewed refused even to consider allowing clean air to be clouded with power plant emissions, no matter how much money they were hypothetically offered. Sagoff suggests that the participants rightly questioned the premise of the research, because they felt that Congress, as the representative of the public will, had already settled the issue when it passed the Clean Air Act.

The Triumph of Economic Thinking?

Sagoff's democratic vision is attractive because it resonates with some of our most cherished cultural traditions. According to the author, we don't have to wait for an expansion in environmental consciousness or to reject our capitalist, free-market economy. We can resolve conflicting claims on our natural endowments through the existing political process. But when it comes to proposing concrete alternatives for environmental regulation, Sagoff's vision begins to break down.

Instead of using a mechanical methodology like cost-benefit analysis, he maintains, regulators should work more like jurors at a trial. They should steep themselves in the empirical details of each regulatory situation and make case-by-case judgments that balance conflicting interests and social goals and match ends to means. Such an approach would require the cooperation of agencies, industry, and public interest groups to establish a reasonable level of pollution in view of social norms and economic facts.

But one begins to suspect that Sagoff's alternative is as abstract and out of touch with political realities as the cost-benefit method he criticizes. The fact is, politics is never so neat as Sagoff's idealized vision of the political sphere suggests. Conflicting interest groups rarely have rational discussions; they pursue their interests single-mindedly. Regulators are not always neutral representatives of the public interest; they often reflect the points of view of the industries they are regulating. Most important, wide differences of power, influence, and access to resources distort the political process.

In addition, Sagoff doesn't address a deeper historical issue. His description of the political sphere reflects an eighteenth-century

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REVIEWS

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view of democracy. But does such a theory still speak to the realities of a late-twentieth-century technological society? The very dominance of economic thinking as reflected in cost-benefit analysis may be merely a symptom of the real problem—the steady erosion of the political sphere in modern society. Countering this trend will require more than simply reasserting the traditional virtues of democratic politics.

Still, Sagoff's basic insight is sound. Ideally, it is in the political forum, where rational arguments count—rather than in the marketplace, where interests are merely calculated—that we will find the best guidance for using the earth's resources wisely. The question remains how to revive our democratic politics so that the reality matches the ideal. ■

DANIEL GROSSMAN writes on the environment and science policy.

LETTERS

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FOREIGN POLICY IN THE 1990s

In "Hard Choices: Defense Policy after the Crash" (*TR October 1988*), Michael Klare and David Callahan correctly point out that economics will bring long-delayed choices to the fore. A parallel discussion of the international repercussions would complete a disturbing picture of the strategic environment in the 1990s. Our military commitments are the product of over 40 years of political relations. Also, the world community appears to be growing more complex. Patterns of superpower conflict seem to be changing, and so do the relations between the superpowers and their respective alliances.

Some sort of comprehensive vision of the path that the United States ought to follow in the next decade is essential if key opportunities are to be exploited and potentially dangerous circumstances handled safely. It is particularly disconcerting, then, to see a debate structured solely by budgetary concerns. The hard choices the authors elucidate are real, but their wider significance will not be revealed if the United States remains incapable of articulating long-range goals. In short, we may have to reformulate the relationship between the president's primacy in foreign policy and congressional prerogatives in funding national-security activities. In the absence of a consensus on major issues, policy is likely to remain reactive—and ineffective in meeting new challenges.

BRIAN D. MUSSINGTON
Ottawa, Canada

HARRISON

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ing facility in the United States. The hope is that the mill can be modernized to serve another speciality niche—advanced steel plates for U.S. Navy ships.

Other SVA projects would adapt closed plants for new industries. Projects on the drawing board include a recycling center for newspapers, clear glass, and metal cans; a printing company that could service downtown Pittsburgh offices; a factory for making infrared cooking equipment; and a food-processing plant. In each case, managers with long-term experience and roots in the the Mon Valley have been recruited to help in the planning.

Finally, the authority is working closely with Pittsburgh's Urban Redevelopment Agency, to set up an "early warning network" for alerting the community to future plant closings before they happen. Consisting of shop-floor committees at companies throughout the region, the network will identify plants in danger of closing, help coordinate state aid and technical assistance, and, where shutdown is inevitable, plan for the resulting layoffs.

Through such initiatives, Pittsburgh and the towns in its metropolitan area are attempting to create a dynamic, balanced economy consisting not only of high-tech services but also of modern industrial enterprises that can draw on the skills of the region's large manufacturing workforce. If they succeed, the SVA's principle that effective industrial revitalization requires the direct involvement of the workforce may become an important model for other depressed manufacturing regions. ■

FLORMAN

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among employees. About 200 major companies have set up formal systems in which a senior executive outside the regular chain of command is available to deal confidentially with employee grievances and alarms. For instance, after fraudulent billing in its defense electronics business came to light in 1985, General Electric appointed a top executive from the company's internal financial controls operation as ombudsman.

We will never eliminate the need for honorable and courageous technologists, nor would we wish to. But a system that relies on heroism is neither stable nor efficient. A society that expects martyrdom from its citizens is neither wise nor noble.

Perhaps Roger Boisjoly's greatest contribution will lie less in encouraging others to emulate his actions than in rousing the rest of us to develop procedures that make sacrifices like his as rare as possible. ■

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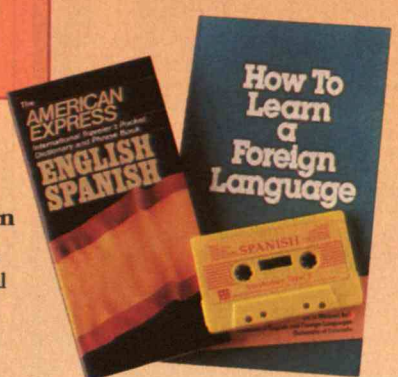

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MIT Reporter

Frustration Over Cold Fusion

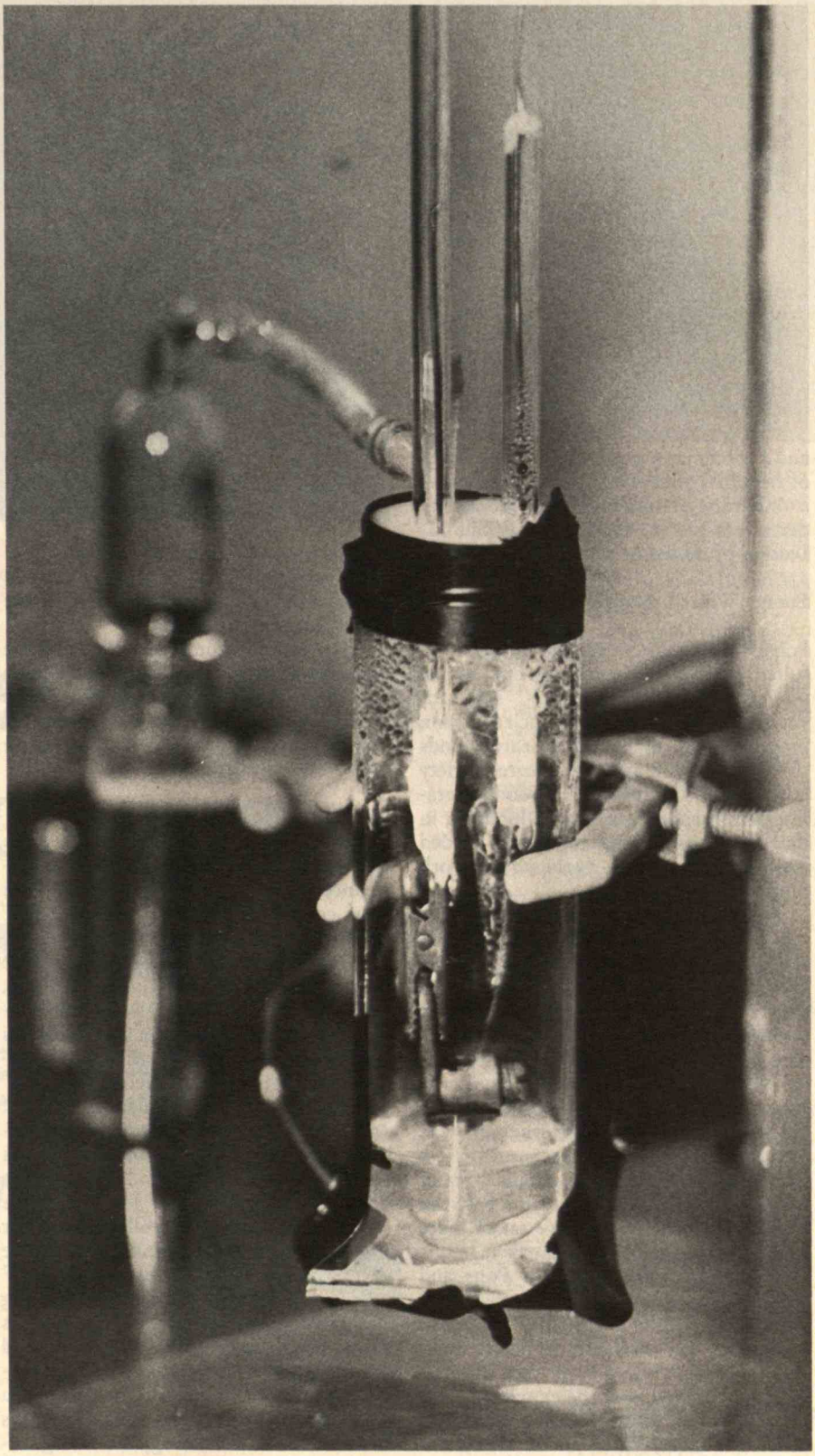
When Keith H. Johnson learned about the cold fusion process that supposedly emits more than four times the energy it uses, he was relieved. He expected the announcement would finally divert public attention from superconductivity, his specialty. But soon, like many others at MIT, the materials science and engineering professor dropped almost all other work to explore whether the idea could stand up as a remarkable new source of energy.

Six weeks after the brouhaha began—with a number of MIT researchers having pulled all-nighters on the task—nobody at the Institute was willing to say that the process worked. "I can only be skeptical," said Ronald R. Parker, the director of the Plasma Fusion Center who headed an ad hoc group of some 15 MIT researchers from different departments who tried to reproduce the process.

Originally it appeared that the experiment, conducted by chemists B. Stanley Pons of the University of Utah and Martin Fleischmann of the University of Southampton in England, would be easy to replicate quickly because of the simplicity of the equipment, materials, and process. The experiment involved running electricity through a test tube containing electrodes—one of which is made of palladium—and heavy water, which includes deuterium rather than hydrogen.

But the Parker group not only was unable to detect an excess amount of heat, but could not obtain any neutrons above those measured at background levels.

Neutrons are an important by-product of heat in every known kind of fusion. For example, when two deuterium atoms fuse, they can produce either a neutron plus helium-3 or a proton plus tritium. The proportion of resulting neutrons depends on the temperature at which the deuterium atoms fuse. Current scientific knowledge leads to the conclusion that Pons and Fleischmann's experiment should have yielded on the order of 10 trillion neutrons



An ad hoc group of some 15 MIT researchers from different departments tested Pons and Fleischmann's experiment using apparatus such as this.

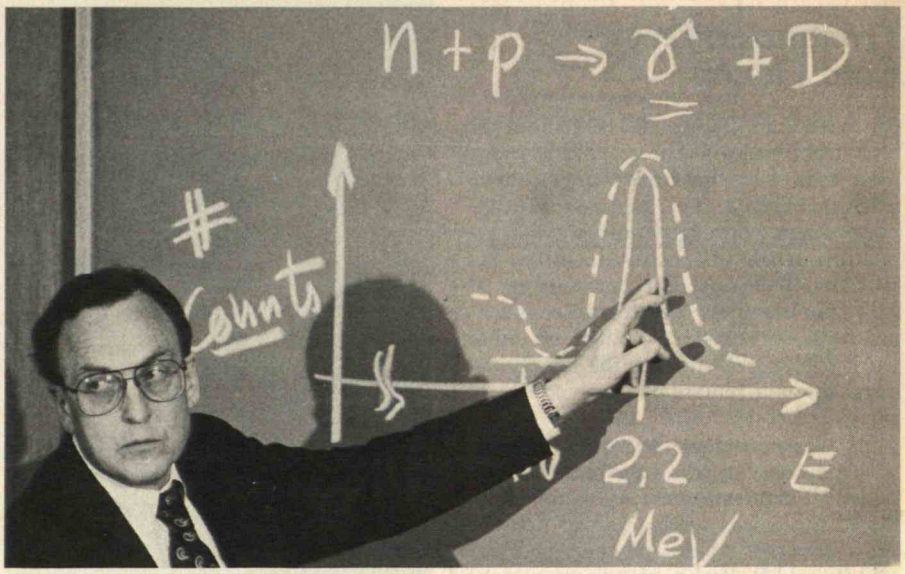
PHOTO: DONNA COVENEY

MIT Reporter

per second—enough to kill the researchers. But Pons and Fleischmann said their experiment yielded only 40,000 neutrons per second, and suggested that a new kind of fusion must be taking place.

Parker says his group is "certain" that Pons and Fleischmann's experiment didn't yield even that many neutrons—by at least several orders of magnitude. The MIT researchers concluded this because of an experiment in which they submerged a known source of neutrons in water, producing gamma radiation that the scientists plotted as a bell curve. This curve differed significantly from a gamma-radiation curve that Pons and Fleischmann plotted from their experiment.

MIT researchers also doubt that Pons and Fleischmann produced the quantities of helium-4 that they claimed. Helium-4 is only rarely found as an end product of deuterium fusion, explains Lawrence M. Lidsky, professor of nuclear engineering.



Ronald R. Parker, director of MIT's Plasma Fusion Center, shows that a bell curve of gamma radiation that MIT researchers obtained differed from a curve Pons and Fleischmann produced.

Energy Wasted, Not Gained

Pons and Fleischmann's methods have resulted in "an extraordinary amount of wasted motion, wasted energy," says Lidsky, a critic of the standard nuclear-fusion program who thinks that research funds should be spread among a greater variety of projects. The researchers' documentation was "crude," points out Johnson, in that it did not describe the details needed for other scientists to duplicate the work precisely.

Not only did scientists at first have to rely on articles in the popular press, but the paper that Pons and Fleischmann published after announcing their results in a press conference did not include a control experiment based on ordinary instead of heavy water. If hydrogen molecules produced the same results, it would have challenged the chemists' contention that the deuterium-palladium interaction was what mattered. And an absence of excess heat in an experiment with ordinary water would have indicated that fusion between deuterium nuclei might have taken place in the heavy water experiment.

There are a "lot of things Pons and Fleischmann are saying now that they didn't say in the beginning," Johnson comments. For example, he says, originally they didn't point out that the palladium hardened after the experiment ran for some time. Johnson believes that this outcome indicates that a chemical reaction is taking place, since such reactions degrade materials. That in turn would mean that as much energy is being used in the process as is emitted.

There was also the wasted time that the principal scientists at MIT and elsewhere had to spend with the media, who deluged them for interviews. Parker received hundreds of such calls, including one from CBS News at midnight.

Should the First Stop Be the Media?

The fact that Pons and Fleischmann announced their discovery March 23 in a press conference also annoyed some MIT scientists. The two had a "moral obligation" to make sure that their findings were peer reviewed, says Ronald G. Ballinger, Carl Richard Soderberg Associate Professor of Nuclear Engineering and Materials Science and Engineering, one of the principal scientists in the Parker group.

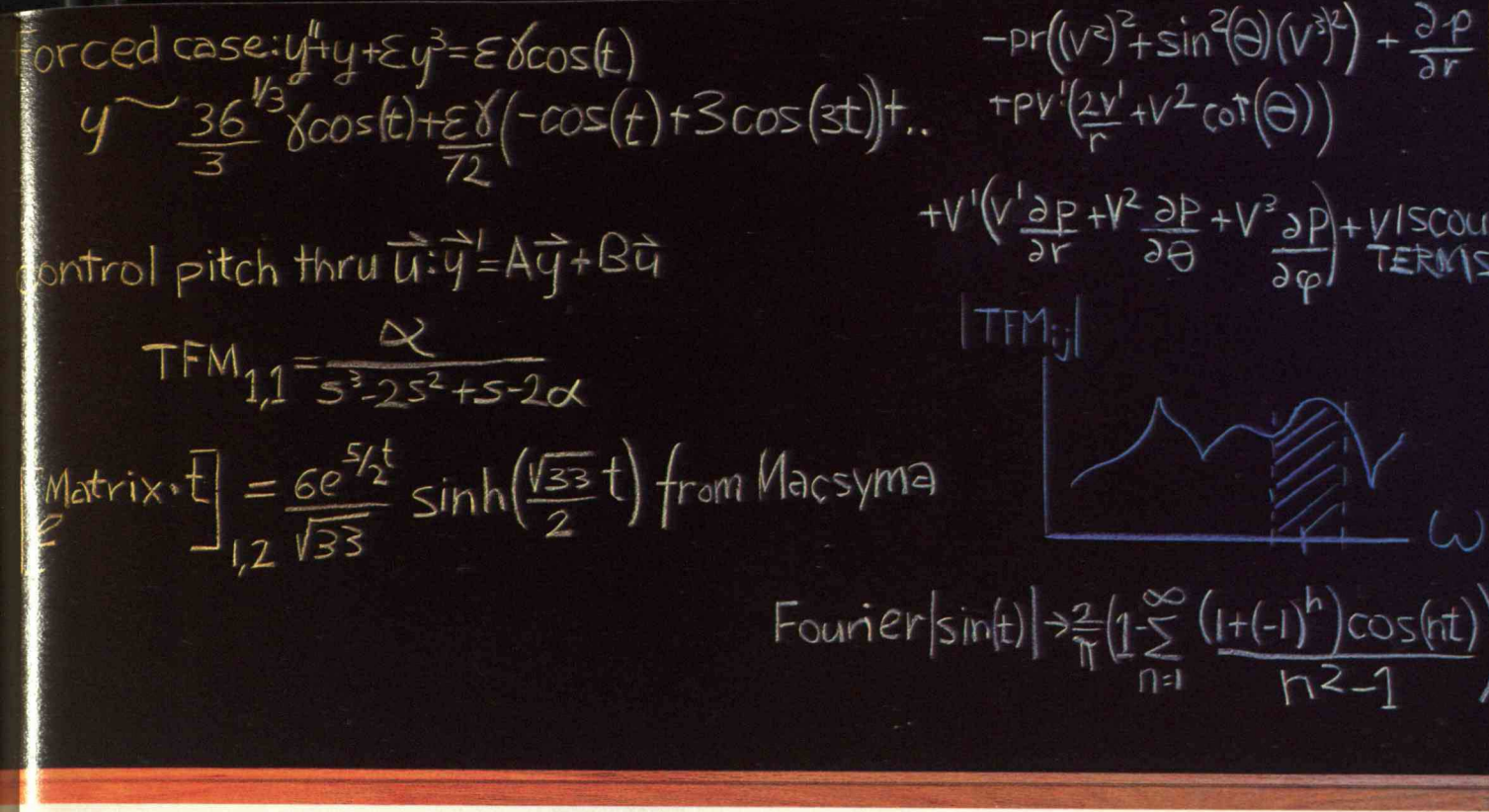
However, Mark S. Wrighton, head of MIT's Department of Chemistry and another principal with the group, expresses some sympathy for Pons and Fleischmann. "With a major discovery like this, there would be no way of controlling the rumor mill," he says. "How would you behave if you thought you'd just discovered fire?"

MIT didn't help matters by announcing April 14 that it had applied for patents based on a theory explaining how cold fusion could occur, say several researchers. That was a "mistake," comments John M. Deutch, MIT provost, although he says the Institute's Technology Licensing Office is correct to be "responsive to individual faculty members who wish to have their work protected." (Associate professor of electrical engineering and computer science Peter L. Hagelstein, who submitted this theory to *Physical Review Letters,* declined to be interviewed.)

Parker labels "preposterous" the University of Utah's $25 million request from Congress for help in building a fusion center before the experiment had been verified. And Ballinger, who testified before the House Committee on Science, Space, and Technology on the same day as the University of Utah, calls the school's testimony "a well-orchestrated effort . . . to circumvent the peer-review process."

Nevertheless, the events show that different members of the U.S. scientific enterprise could quickly galvanize and work together with open minds, Wrighton says. And Parker expected that some MIT researchers would continue conducting experiments related to Pons and Fleischmann's work into the summer. After six weeks of work, Parker was not ready to rule out some fusion process of purely "scientific interest" related to a compound of palladium and deuterium. "While we all regret the great hype," he says, the idea "got a lot of people to think in very creative ways."

PHOTO: THE BOSTON GLOBE



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